ELSEVIER
JAI

RESEARCH IN TRANSPORTATION ECONOMICS
VOLUME 18

BUS TRANSPORT: ECONOMICS, POLICY AND PLANNING

DAVID A. HENSHER

BUS TRANSPORT: ECONOMICS, POLICY AND PLANNING

RESEARCH IN TRANSPORTATION ECONOMICS

Series Editor: Martin Dresner

Volumes 1–6:	Research in Transportation Economics – B. Starr McMullen
Volume 7:	Railroad Bankruptcies and Mergers from Chicago West 1975–2001: Financial Analysis and Regulatory Critique – Michael Conant
Volume 8:	Economic Impacts of Intelligent Transportation Systems: Innovations and Case Studies – Evangelos Bekiaris and Yuko Nakanishi
Volume 9:	Road Pricing: Theory and Evidence – Georgina Santos
Volume 10:	Transportation Labor Issues and Regulatory Reform – James Peoples and Wayne K. Talley
Volume 11:	Interurban Road Charging for Trucks in Europe – José Manuel Viegas
Volume 12:	Shipping Economics – Kevin Cullinane
Volume 13:	Global Competition in Transportation Markets: Analysis and Policy Making – Katsuhiko Kuroda and Adib Kanafani
Volume 14:	Measuring the Marginal Social Cost of Transport – Christopher Nash and Bryan Matthews
Volume 15:	Procurement and Financing of Motorways in Europe – Giorgio Ragazzi and Werner Rothengatter
Volume 16:	Port Economics – Kevin Cullinane and Wayne K. Talley
Volume 17:	Devolution, Port Governance and Port Performance – Mary R. Books and Kevin Cullinane

RESEARCH IN TRANSPORTATION ECONOMICS VOLUME 18

BUS TRANSPORT: ECONOMICS, POLICY AND PLANNING

BY

DAVID A. HENSHER

Institute of Transport and Logistics Studies, Faculty of Economics and Business, University of Sydney, Sydney, NSW, 2006, Australia

ELSEVIER
JAI

Amsterdam – Boston – Heidelberg – London – New York – Oxford
Paris – San Diego – San Francisco – Singapore – Sydney – Tokyo

JAI Press is an imprint of Elsevier

JAI Press is an imprint of Elsevier
The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK
Radarweg 29, PO Box 211, 1000 AE Amsterdam, The Netherlands
525 B Street, Suite 1900, San Diego, CA 92101-4495, USA

First edition 2007

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN-13: 978-0-7623-1408-9
ISBN-10: 0-7623-1408-7
ISSN: 0739-8859 (Series)

Printed and bound in The Netherlands

07 08 09 10 11 10 9 8 7 6 5 4 3 2 1

Dedicated to the Bus and Coach Association of New South Wales

This page intentionally left blank

CONTENTS

ABOUT THE AUTHOR *xix*

LIST OF CHAPTERS AND PREVIOUS SOURCES OF PUBLICATION *xxi*

LIST OF FIGURES *xxiii*

LIST OF TABLES *xxv*

CHAPTER 1 INTRODUCTION *1*

CHAPTER 2 ORGANISATION AND OWNERSHIP OF PUBLIC TRANSPORT SERVICES

2.1 Introduction *5*
2.2 Organisational Reform Developments *6*
2.3 Other Issues *11*
  2.3.1 Market Concentration *11*
  2.3.2 Cross-Modal Ownership *12*
  2.3.3 Monitoring of Performance *13*
  2.3.4 Growing the Human Skill Base *13*
2.4 Recommendations for Ongoing Consideration *14*

CHAPTER 3 USER NEEDS AND IMPACT ON PUBLIC TRANSPORT

3.1 Introduction *15*
3.2 Service Effectiveness in Diversified Markets *16*
3.3 Quality Partnerships *17*

3.4 Service Effectiveness and Contracts *18*
3.4.1 Monitoring and Responses *20*
3.5 Recommendations *21*

CHAPTER 4 CONTRACTING OPTIONS

4.1 Introduction *25*
4.2 Definitional Issues for Performance-Based Contracts (PBCs) *27*
4.3 Procuring Services through Competitively Tendered or Negotiated Contracts – The Issues *30*
4.3.1 Cost and Subsidy Impacts *31*
4.3.2 Administration and Regulatory Costs *32*
4.3.3 Establishment of Appropriate Benchmarks *32*
4.3.4 Accountability and Transparency *32*
4.3.5 Optimising Networks and Funding Allocation *33*
4.3.6 Some Development, Performance Incentives and Monitoring *33*
4.3.7 Government-Funding Risks *34*
4.3.8 Encouragement of a Strong, Diverse Supplier Market *34*
4.4 Payment Models *35*
4.5 Other Issues *39*
4.6 Conclusions and Recommendations for Ongoing Inquiry *41*

CHAPTER 5 CONTRACT AREAS AND SERVICE QUALITY ISSUES IN PUBLIC TRANSIT PROVISION: SOME THOUGHTS ON THE EUROPEAN AND AUSTRALIAN CONTEXT

5.1 Introduction *47*
5.2 Contract Area Size and Number *48*
5.2.1 The Theoretical Argument *53*
5.2.2 The Evidence on Cost Savings from Scale of Operations *54*
5.2.3 Summary of the Main Argument *55*

5.3 Integrated Fares: Regulatory Control and/or Genuine Benefit to Passengers? *57*
5.3.1 What is the Broader Evidence on Patronage Benefits? *60*
5.4 Conclusions *61*

CHAPTER 6 PERFORMANCE-BASED QUALITY CONTRACTS IN BUS SERVICE PROVISION

6.1 Introduction *67*
6.2 The Appeal of PBC *68*
6.3 The Hordaland (Norway) and New Zealand Models: A Healthy Starting Position *72*
6.3.1 Hordaland *72*
6.3.2 New Zealand *74*
6.3.3 Assessment *76*
6.4 A Proposed Performance-Based Quality Contract Regime for Australia *76*
6.5 Conclusion *79*

CHAPTER 7 PERFORMANCE-BASED QUALITY CONTRACTS FOR THE BUS SECTOR: DELIVERING SOCIAL AND COMMERCIAL VALUE FOR MONEY

7.1 Introduction *81*
7.2 Incentive-Based Performance Contracts *84*
7.3 The Australian PBC Proposition *86*
7.3.1 Defining Annual Passenger Demand *87*
7.3.2 Defining Annual Total Cost *88*
7.3.3 Defining the Constraints *89*
7.3.4 Defining the Objective Function *93*
7.3.5 Defining the Benefit Sources *93*
7.4 A Case Study for the Outer Metropolitan Area of Sydney *97*
7.4.1 The Budget and %MSL in Scenario I *97*
7.4.2 Fleet Size under Scenario I *100*

7.5 Conclusions and Future Research Directions *103*

CHAPTER 8 DELIVERING VALUE FOR MONEY TO GOVERNMENT THROUGH EFFICIENT AND EFFECTIVE PUBLIC TRANSIT SERVICE CONTINUITY: SOME THOUGHTS

8.1 Introduction *105*
8.2 The Indisputable Strategic Objective of Government on behalf of Society *106*
8.3 Trust, Cooperation and Collaboration *106*
8.4 Supporting Efficiency and Effectiveness through the Life of a Contract (and not at the Time of Tendering) *107*
8.5 Asset Ownership – a Key Issue Linked to the Boundaries of a Transit Operator's Business *109*
8.6 Conclusions *113*

CHAPTER 9 MELBOURNE'S PUBLIC TRANSPORT FRANCHISING: LESSONS FOR PPPS

9.1 Scope *123*
9.2 Train and Tram Franchising in Victoria, Australia *124*
9.2.1 Context *124*
9.2.2 Objectives *125*
9.2.3 Remuneration Components *126*
9.2.4 Expected Outcomes from Franchising *127*
9.3 Antecedents *128*
9.4 Outcomes from Franchising *129*
9.4.1 The High Profile Outcome *129*
9.4.2 Financial Outcomes to the State *130*
9.4.3 Service Quality *132*
9.4.4 New Vehicles *133*
9.4.5 Increases in Services *133*
9.4.6 Patronage *134*
9.4.7 Risk Transfer *134*
9.4.8 Safety Outcomes *135*
9.4.9 Customer Satisfaction *135*
9.5 Overview *135*

9.6 Why has the Process Failed to Deliver? *136*
9.6.1 Operator Motivations and Governmental Reform Ideology *136*
9.6.2 Competitive Tendering versus Negotiated (Performance-Based) Contracts *138*
9.6.3 Area Agreements/Quality Partnerships *140*
9.6.4 Risk Sharing *142*
9.7 Melbourne's Emerging New Arrangements *143*
9.8 Concluding Comments *143*

CHAPTER 10 ESTABLISHING A FARE ELASTICITY REGIME FOR URBAN PASSENGER TRANSPORT

10.1 Introduction *145*
10.2 Microeconomic Specification of the Indirect Utility Function for Choice Alternatives *147*
10.3 Specifying a Choice Model *151*
10.3.1 The Inseparability of Taste and Scale *152*
10.3.2 Random Effects Heteroscedastic Extreme Value Model *154*
10.4 The Empirical Context *156*
10.4.1 Sourcing Revealed and Stated Preference Data *157*
10.4.2 Developing the Stated Choice Experiment *158*
10.5 Empirical Results *160*
10.5.1 Response Rates *160*
10.5.2 Empirical Models *161*
10.5.3 Fare Type and Car Cost Direct and Cross Share Elasticities *167*
10.6 Conclusions *171*

CHAPTER 11 PRESERVING THE SYMMETRY OF ESTIMATED COMMUTER TRAVEL ELASTICITIES

11.1 Introduction *173*
11.2 Choice and Ordinary Elasticities *174*
11.3 Aggregate Demand and HEV Properties *176*
11.3.1 Symmetry *176*
11.3.2 Share Weighted Column Sum *180*

11.3.3 Gross Substitutes *182*
11.4 The Model *182*
11.5 The Empirical Context *184*
11.6 Results *185*
11.7 Indicative Comparisons with Other Estimates *187*
11.8 Conclusions *189*

CHAPTER 12 TRESIS (TRANSPORT AND ENVIRONMENTAL STRATEGY IMPACT SIMULATOR): A CASE STUDY

12.1 Introduction *195*
12.2 Detailed Background to TRESIS *196*
12.3 Application Issues *202*
12.4 Warringah Case Study *204*
12.4.1 Detailed Results *205*
12.5 Conclusions *211*

CHAPTER 13 PRODUCTIVITY MEASUREMENT IN THE URBAN BUS SECTOR

13.1 Introduction *221*
13.2 Measuring performance – Total Factor Productivity *223*
13.3 Data Requirements and the Sourcing of Data *225*
13.3.1 Sourcing the Data *226*
13.3.2 State Differences in Private Bus Operations *226*
13.3.3 Subsidies *227*
13.3.4 Use of Coaches and Buses *227*
13.3.5 Costs *228*
13.3.6 Specifying the Outputs and Inputs *228*
13.4 Descriptive Profile of the Urban Bus Sector 1991/1992 *232*
13.5 Gross Total Factor Productivity *236*
13.5.1 Gross TFP *236*
13.5.2 Decomposing GTFP to Identify Sources of Productivity Differences *246*
13.6 Concluding Comments *256*

CHAPTER 14 A SERVICE QUALITY INDEX FOR AREA-WIDE CONTRACT PERFORMANCE ASSESSMENT

14.1 Introduction *259*
14.2 The Search for an Operational Indicator of Service Quality *260*
14.3 The Stated Preference Paradigm *261*
14.4 Defining the Empirical Setting and the SP Experiment *262*
14.5 Results of the User Preference Model *264*
14.6 The Service Quality Indicator (SQI) *269*
14.7 Operationalising SQI as a Regulatory Tool *270*
14.7.1 Integrating SQI Targets in the Specification of Tenders *270*
14.7.2 Establishing the Actual Target *274*
14.7.3 Monitoring and Responses *275*
14.8 Conclusions *276*

CHAPTER 15 DEVELOPING A SERVICE QUALITY INDEX (SQI) IN THE PROVISION OF COMMERCIAL BUS CONTRACTS

15.1 Background *277*
15.2 Data Requirements and Attribute Selection for Service Quality Measurement *279*
15.2.1 The Stated Preference Approach *279*
15.2.2 Defining the Empirical Setting and the SP Experiment *280*
15.2.3 Sampling Strategy *280*
15.2.4 Logistical Issues in Data Collection *282*
15.3 Sample Response *283*
15.4 Statistical Analysis to Quantify Service Quality *286*
15.4.1 SQI and Importance Weights *286*
15.4.2 Benchmarking and Discrete Choice Modelling *289*
15.4.3 SQI Model *290*
15.4.4 Benchmarking Service Quality *293*
15.4.5 Determining SQI at the Depot Level and in the Future *297*
15.5 Conclusions *298*

CHAPTER 16 NON-COMMERCIAL CONTRACT REIMBURSEMENT: THE INSTITUTE OF TRANSPORT STUDIES (ITS) MODEL

16.1 Introduction *299*
16.2 Quality of Survey Data *300*
16.2.1 Cleaning the Data *300*
16.3 The ITS Model *303*
16.3.1 Asset Replacement Value *303*
16.3.2 Calculating the ACC *304*
16.3.3 Discussion *305*
16.3.4 Bus-Related Costs *306*
16.3.5 Factoring of Costs from Year to Year *306*
16.3.6 Changes to Categories and Costs *307*
16.3.7 Distance-Related Costs *311*
16.3.8 Factoring of Costs from Year to Year *312*
16.3.9 Changes to Categories and Costs *312*
16.3.10 Gravel Roads *314*
16.3.11 Driver-Related Costs *315*
16.4 Justifiable Factors for 2003 *315*
16.4.1 Risk *315*
16.4.2 Real Rate of Interest *318*
16.4.3 Loan Rate *318*
16.4.4 CPI *318*
16.4.5 Fuel Price *319*
16.4.6 Capital Cost *320*
16.4.7 Wage Rates *320*
16.4.8 Residual Rate of Buses *320*
16.4.9 Economic Life *321*
16.5 Comparison of PwC and ITS Models *321*
16.5.1 Look and Feel *321*
16.5.2 Calculations – Category Four in 2002 Dollars *322*
16.5.3 Calculations – Category Four in 2003 Dollars *322*
16.6 Updating Costs to Current Dollars *323*
16.6.1 Risk *324*
16.6.2 Real Rate of Interest or Risk-Free Investment amount *325*

16.6.3 Loan Rate *325*
16.6.4 CPI *325*
16.6.5 Fuel Price *325*
16.6.6 Residual Rate *326*
16.6.7 Capital Cost *326*
16.6.8 Component Costs *326*
16.6.9 Wage Rates *326*
16.7 Summary *326*

CHAPTER 17 A BUS-BASED TRANSITWAY OR LIGHT RAIL? CONTINUING THE SAGA ON CHOICE VERSUS BLIND COMMITMENT

17.1 Introduction *353*
17.2 Taking a Closer Look at Light Rail and Bus-Based Transitways *355*
17.3 More on the Cost of Alternative Systems *359*
17.4 More on Patronage? *362*
17.5 Impacts of Public Transport Facilities on Land Use *368*
17.6 An Assessment of Current Experience *373*
17.7 Conclusions *376*

CHAPTER 18 THE FUTURE OF EXCLUSIVE BUSWAYS: THE BRAZILIAN EXPERIENCE

18.1 Introduction *379*
18.2 Brazil: National History and Profile *380*
18.2.1 History *380*
18.2.2 Population Trends *381*
18.2.3 Regulation of Urban Transport *382*
18.2.4 Fare Systems, Funding and Operator Contracts *386*
18.2.5 Ownership Structures *388*
18.2.6 Urban Planning *389*
18.2.7 Development and Operation of Busways *392*
18.2.8 Brazilian Busways in the Future – Current Proposals *401*
18.3 Conclusion *404*

CHAPTER 19 THE IMBALANCE BETWEEN CAR AND PUBLIC TRANSPORT USE IN URBAN AUSTRALIA: WHY DOES IT EXIST?

19.1 Introduction *407*
19.2 The Challenges Facing Public Transport *410*
19.3 What does this mean for Public Transport? *412*
19.3.1 The Role of Transport Systems in the Household Sector in Guiding Changes to the Urban Form is Declining *412*
19.3.2 The Urban Area of the Future is likely to Exhibit a Particular Pattern of 'Compactness' *413*
19.3.3 The Automobile is Becoming 'Greener': Automobile Technology Has a Major Role to Play in Improving Environmental Quality *414*
19.3.4 Pricing Will Need to be Further Promoted to Complement Technology Improvements *414*
19.3.5 Work Practices Can Have a Significant Influence on Total Travel by Time and Place *415*
19.3.6 Do Not Forget the Growing Importance of Business and Non-Commuting Travel Activity in Shaping Our Cities *415*
19.3.7 The Air We Breathe in Urban Australia is Not So Bad *415*
19.3.8 Much of Our Urban Environment Exists and Adaptation Will Be a Long Drawn-out Process *416*
19.3.9 Isolating Freeways and Toll Roads to Assess Their Net Contribution is Very Misleading *416*
19.3.10 Much Progress Has Been Made in Making the Road Environment Safer *417*
19.3.11 Flexible Public Transport Needs More Serious Consideration *417*
19.4 Looking for Niches: Now You are Talking Sense *419*
19.5 The British Challenge to Try and Redress the Imbalance *421*
19.6 Taking a Closer Look at Light Rail or Trams *422*
19.7 Concluding Thoughts: The Key Challenges Remain *426*
19.7.1 Some of the Main Points to Debate are: *426*
19.7.2 A Final Word: 'Horses for Courses' in the Reform of Public Transport *428*

CHAPTER 20 URBAN PUBLIC TRANSPORT DELIVERY IN AUSTRALIA: ISSUES AND CHALLENGES IN RETAINING AND GROWING PATRONAGE

20.1 Introduction *431*
20.2 Big Themes and Key Sentiments *433*
20.3 Practices that Offer Patronage Opportunities *435*
20.4 Three High Agenda Themes to Grow Patronage *438*
20.4.1 Rethinking Stereotypical Segments of Potential Public Transport Users *438*
20.4.2 The Niche Hard Sell – Individualised Marketing *440*
20.4.3 Technology at Play *441*
20.5 Concluding Comments *442*

CHAPTER 21 URBAN PUBLIC TRANSPORT AGENDAS AND CHALLENGES

21.1 Introduction *445*
21.2 Changing the Balance in Favour of Public Transport *446*
21.3 The Ongoing Debate on Technological Forms of Public Transport: Bus Systems and Light Rail Revisited Yet Again! *451*
21.4 Environmental Matters and Buses *454*
21.5 Service Quality and Your Customers: The Ultimate Purpose *458*
21.6 Concluding Thoughts: Transport-Friend or Foe? *460*

NOTES *465*

REFERENCES *489*

SUBJECT INDEX *505*

This page intentionally left blank

ABOUT THE AUTHOR

David Hensher is Professor of Management, and director of the Institute of Transport and Logistics Studies: The Australian Key Centre of Teaching and Research in Transport Management in The Faculty of Economics and Business at The University of Sydney. David is a Fellow of the Academy of Social Sciences in Australia, past president of the International Association of Travel Behaviour Research and a past vice-chair of the International Scientific Committee of the World Conference of Transport Research. David is on the editorial boards of 10 of the leading transport journals and area editor of *Transport Reviews*. David is series and volume editor of the handbook series "Handbooks in Transport" published by one of the world's most prestigious academic publishing houses – Elsevier/Pergamon press. He has published extensively (over 350 papers) in the leading international transport journals and key journals in economics as well as five books. His most recent books are on the *Demand for Automobiles*, published by North-Holland the *Bus and Coach Business* (Allen and Unwin), *Transport: An Economics and Management Perspective* (Oxford Univeristy Press), *Stated Choice Methods* (with Jordan Louviere and Joffre Swait – Cambridge University Press) and *Applied Choice Analysis – A Primer* (with John Rose and William Greene-Cambridge University Press). His particular interests are transport economics, transport strategy, sustainable transport, productivity measurement, traveller behaviour analysis, stated choice experiments, dynamic discrete-continuous choice modelling, and institutional reform. David has advised numerous government and private sector organisations on matters related to transportation especially matters related to forecasting demand for existing and new transportation services, for example, the Speedrail project, the Liverpool–Parramatta Transitway, the North-West Sydney Transport Study, the M2, M4, M5, M4 East, the F3 and Brisbane toll roads. David is regarded as Australia's most eminent expert on matters relating to travel demand. Appointments have included: a member of the executive committee that reviewed bus transport bids for the 2000 Olympic Games, the NSW Government's Peer Review Committee for the Strategic Transport Plan, peer reviewer for Transfund of the New Zealand (NZ) project evaluation program, adviser to NZ Land Transport on the 2006 Review of procurement of passenger transport, and a member of the executive committee of ATEC, a consortium promoting a freight rail system between Melbourne and Darwin.

This page intentionally left blank

LIST OF CHAPTERS AND PREVIOUS SOURCES OF PUBLICATION

Chapter 1 Introduction . . . 1
Chapter 2 Organisation and Ownership of Public Transport Services (Transport Reviews). . . . 5
Chapter 3 User Needs and Impact on Public Transport (Transport Reviews) . . . 15
Chapter 4 Contracting Options (Elsevier Book) . . . 25
Chapter 5 Contract Areas and Service Quality Issues in Public Transit Provision: Some Thoughts on the European and Australian Context (Journal of Public Transportation) . . . 47
Chapter 6 Performance-Based Quality Contracts in Bus Service Provision (Transportation Research A) . . . 67
Chapter 7 Performance-Based Quality Contracts for the Bus Sector: Delivering Social and Commercial Value for Money (Transportation Research B) . . . 81
Chapter 8 Delivering Value for Money to Government through Efficient and Effective Public Transit Service Continuity: Some Thoughts. . . . 105
Chapter 9 Melbourne's Public Transport Franchising: Lessons for PPPs (Elsevier Book) . . . 123
Chapter 10 Establishing a Fare Elasticity Regime for Urban Passenger Transport (Journal of Transport Economics and Policy) . . . 145
Chapter 11 Preserving the Symmetry of Estimated Commuter Travel Elasticities (Transportation Research B). . . . 173
Chapter 12 TRESIS (Transport and Environmental Strategy Impact Simulator): A Case Study (Transportation Research Record). . . . 195
Chapter 13 Productivity Measurement in the Urban Bus Sector (Transport Policy) . . . 221
Chapter 14 A Service Quality Index for Area-Wide Contract Performance Assessment (Journal of Transport Economics and Policy) . . . 259

Chapter 15 Developing a Service Quality Index (SQI) in the Provision of Commercial Bus Contracts (Transportation Research A) 277
Chapter 16 Non-Commercial Contract Reimbursement: The Institute of Transport Studies (ITS) Model (not published) 299
Chapter 17 A Bus-Based Transitway or Light Rail? Continuing the Saga on Choice versus Blind Commitment (Roads and Transport Research) 353
Chapter 18 The Future of Exclusive Busways: The Brazilian Experience (Transport Reviews) 379
Chapter 19 The Imbalance between Car and Public Transport Use in Urban Australia: Why Does it Exist? (Transport Policy) 407
Chapter 20 Urban Public Transport Delivery in Australia: Issues and Challenges in Retaining and Growing Patronage (Roads and Transport Research) . . 431
Chapter 21 Urban Public Transport Agendas and Challenges (not published) 445

LIST OF FIGURES

Figure 2.1 Structural and organisational coherence of the system 10
Figure 4.1 Contract components 28
Figure 4.2 Processes for procurement and payment rates determination 29
Figure 5.1 The Sydney metropolitan area and STA contract area 50
Figure 7.1 Composite demand function – negative slope 95
Figure 7.2 Composite demand function – positive slope 95
Figure 7.3 Returns to fleet size under Scenario I 102
Figure 7.4 Returns to fleet size under pure MSL 103
Figure 9.1 Expected periodic payments to Melbourne 127
Figure 9.2 On-time performance of Melbourne's trains and trams 128
Figure 9.3 Cancellations of Melbourne trains and tram services as per cent of services scheduled 133
Figure 11.1 Length of Run and Urban Travel Elasticities 175
Figure 12.1 TRESIS structure 197
Figure 13.1 The essential dimensions of performance measurement 222
Figure 13.2 Cost shares of inputs (using calculated opportunity cost of capital) 241
Figure 14.1 The Service Quality Index 270
Figure 14.2 The composition of the service quality index (all operators in the sample) 271
Figure 14.3 A comparison of an operator against best practice 274
Figure 15.1 Nesting structures used in model estimation to permit comparisons of SQI between nine segments 290
Figure 15.2 SQI for each segment normalised to 1.0 295
Figure 15.3 Decomposition of SQI into its components for each segment 296
Figure 16.1 Required revenue for a category four contract operating for four hours per day, across six distances, the ITS model compared to the PwC model, 2002 dollars 323

Figure 16.2 Required revenue for a category four contract operating for four hours per day, across six distances, the ITS model compared to the PwC model, 2003 dollars 324
Figure 19.1 Train and bus patronage shares 408
Figure 19.2 Trend in car use 408
Figure 19.3 The challenges for urban public transport. 411
Figure 19.4 Profile of casualties and passenger kilometres by mode in urban Australia 418
Figure 19.5 Risk exposure indicator by mode 418
Figure 20.1 The diversity of the new 'stereotype' 439
Figure 21.1 The challenges for urban public transport. 449
Figure 21.2 The benchmarking of mean SQI across operators (operator 25 set = 0). 461
Figure 21.3 The composition of the service quality indicator (difference between operators 16 and 14) 461
Figure 21.4 Operator number 2 versus best practice operator number 19 462

LIST OF TABLES

Table 3.1 Including SQI targets in the contact design 19
Table 3.2 Possible outcomes of a tender 20
Table 5.1 Synthesis of key issues in determining optimal size of operator/contract area 53
Table 5.2 Average day linked trips involving at least one public transport mode, HTS2000 59
Table 7.1 Marginal external costs per car vkm 96
Table 7.2 Subsidy budget and subsidy structure. 98
Table 7.3 Scenario I solution 99
Table 7.4 Total return over route and charter operations 100
Table 7.5 Optimum fleet size strategy 101
Table 10.1 Illustrative set of show cards for the SP experiment 1: Bus or train for a short trip 158
Table 10.2 Profit of public transport commuters by ticket type. . . . 159
Table 10.3 The stated choice experiment fare categories and levels . 160
Table 10.4 HEV model: Joint estimation of SP and RP choices to evaluate the presence of an income effect 162
Table 10.5 MNL model: Joint estimation of SP and RP choices . . . 164
Table 10.6 Summary statistics of estimation sample (standard deviations in parentheses). 165
Table 10.7 Direct and cross share elasticities. 168
Table 11.1 Indicative urban travel elasticities 175
Table 11.2 Illustrative set of show cards for the SP experiment 1: Bus or train for a short trip 185
Table 11.3 Sydney commuters: Trip and spending shares by mode and fare type 186
Table 11.4 Deviations of optimally adjusted own-price elasticities from original estimates: Sydney commuters 186
Table 11.5 Optimally adjusted commuter elasticities condensed to modes 188
Table 11.6 Commuter elasticities condensed to public transport and car 188
Table 12.1 Classification of policy instruments via key input data in TRESIS. 201
Table 12.2 Base year calibration criteria 204

Table 12.3 Summary of major results for each option for the Warringah region using 2020 as a reference point 206
Table 12.4 Total trips with an origin or destination in Warringah for each option 207
Table 12.5 Number of households in Warringah for each option . . 207
Table 12.6 Number of jobs in Warringah for each option 207
Table 12.7 Comparison of total trips with an origin in Zone 13 and a destination in Zones 1–14 208
Table 12.8 Comparison of total travel time for Warringah residents (millions of minutes) 209
Table 12.9 Comparison of total annual toll revenues paid by Warringah residents ('000 dollars) 210
Table 13.1 Selected partial ratio measures of performance, 1991–1992 234
Table 13.2 Summary of GTFP indices, output indices and the aggregate input index 237
Table 13.3 Summary of input indices and associated cost shares, 1991–1992 239
Table 13.4 Quartile incidence of group membership: GTFPpass and GTFPvkm (the latter in parentheses). . . 242
Table 13.5 Quartile incidence of group membership: scale-adjusted TFPpass and scale-adjusted TFPvkm (the latter in parentheses) 242
Table 13.6 Comparison of private operators with their own state public operator. 244
Table 13.7 Establishment of sources of variation in GTFP and scale-adjusted GTFP. 250
Table 13.8 Summary of GTFP, scale-adjusted GTFP and residual TFP indices, 1991/1992. 253
Table 13.9 Quartile incidence of group membership: GTFPpass vs. Residual TFPpass and GTFPvkm vs. Residual TFPvkm (residual TFP in parentheses for TFPpass and TFPvkm, respectively) . . . 255
Table 14.1 The set of attributes and attribute levels in the SP experiment 263
Table 14.2 A typical stated preference exercise 265
Table 14.3 Final user preference model. 266
Table 14.4 Summary statistics of service quality index 269
Table 14.5 Notation for Figure 14.1. 272

Table 14.6 Including SQI targets in the contact design. 272
Table 14.7 Possible outcomes of a tender 275
Table 15.1 Attributes and attribute levels in the SP experiment. . . . 281
Table 15.2 Response rates by segment 284
Table 15.3 Socioeconomic data by segment. 285
Table 15.4 Revealed preference data by segment (categorical variables) 287
Table 15.5 Revealed preference data by segment (continuous variables). 288
Table 15.6 The final model used to identify the importance weights and scale Differences between segments for scheduled route services (school children on passes have been excluded) 291
Table 15.7 SQI and its contributing components by segment (all scaled) 294
Table 15.8 Ranking of the 13 attributes in the SQI 297
Table 16.1 Capital costs of category four vehicles in 2002, survey and industry data 301
Table 16.2 Comparison of the survey and PwC model 'bus related' component costs in 2002 for a category four contract 308
Table 16.3 Revised structure of bus-related costs with components in 2002 309
Table 16.4 'Non-driver labour' component of 'bus-related costs': data and layout for a category four contract, DAFGS eligible, in 2002 dollars 311
Table 16.5 Distance related costs in 2002, ITS model (with revised layout) using survey costs compared to PwC model 313
Table 16.6 Comparison of fuel costs per km between the ITS and PwC models by contract category and DAFGS eligibility, in 2002 dollars. 314
Table 17.1 Volume of passengers using transport corridors in the peak direction of travel during the peak hour 357
Table 17.2 A comparison of ridership rates of a number of USA bus-based transitway systems and LRT systems (the LRT systems selected are regarded as the most 'successful', especially San Diego). 363
Table 17.3 CMTC busways in Sao Paulo – 1994 364
Table 18.1 Urban demographic trends – 1991 382

Table 18.2 Curitiba bus passengers by service and fare type weekday average passenger numbers – 1993. 387
Table 18.3 Fares sold per month by type – 1994 388
Table 18.4 Service characteristics – 1993. 396
Table 18.5 CMTC busways in Sao Paulo – 1994 399
Table 19.1 Volume of passengers using transport corridors in the peak direction of travel during the peak hour 424
Table 19.2 CMTC busways in Sao Paulo – 1994 426
Table 20.1 Recognising the financial and planning capabilities of future scenarios 434
Table 21.1 Profile of the transport task 1981–1997/1998 for Sydney Metropolitan Area: Average weekday 447
Table 21.2 Changes in public transport shares in Sydney 1981–1997/1998 448
Table 21.3 Emission rates from various engine/fuel combinations (g/km). 454
Table 21.4 Euro 3 standards 455
Table 21.5 Alternative evaluation results: 1999 present values, 5% real discount rate 456
Table 21.6 The set of attributes and attribute levels in the SP experiment 459
Table 21.7 A typical stated preference exercise 460
Table 21.8 Notation for Fig. 21.3 463

CHAPTER 1

INTRODUCTION

Public transport is a theme of enormous importance in all societies. The bus is the most patronised of all land-based public passenger modes. It is however seen as a somewhat unglamorous means of supporting mobility and accessibility (in contrast to rail – heavy and light), yet offers so much to the travelling public as well as offering attractive sustainability opportunities. We recognise however that attracting and retaining public transport patronage in general, and bus in particular, is a growing challenge in many countries and will be further exacerbated in economies that are moving towards a high level of economic efficiency and wealth, where the desire and ability to own and use an automobile will continue to impact the future of all forms of land-based public transport, especially for the majority of urban and regional travel.

There is no doubt that the role of urban public transport is continuing to change. The gradual loss of market share in large metropolitan centres, typical of many western cities, is a product of public transport being unable to be responsive to the changing needs of the market, while the car, due to its inherent attributes of flexibility and convenience, keeps pace with people's changing transport needs. If there are three over-riding characteristics portraying the current market profile, it is increasing real wealth for most groups but not all, greater complexity of activities undertaken in the daily life cycle, and the flexibility offered by alternative forms of transport (and non-transport responses such as working from home). These are strong forces of change, which move public transport even further away from meeting many mainstream demands. Certainly, there are some signs of increasing use of public transport (although modal shares are going the other way – for many reasons such as longer train trips to lower priced residential locations), but the impact on the overall transport task is small.

In many Western societies and a growing number of developing economies, motorised urban public bus and rail transport is a niche market provider and looks like being so for the foreseeable future. But what market niches are we talking about? The answer lies in the realm of the diversity of customer needs (both real and latent) and the types of services that can be offered through public transport to capture some (even if small) amounts of particular passenger markets. For example, commuters with a fixed workplace, travelling during the morning and evening peak between two locations with plenty of traffic, *and* who have no commitments before or after work, other than to get to and from home, are good candidates for public transport use; school children; adults on very low household incomes; special events (sporting, cultural, etc.) and the elderly in declining health who cannot drive.

This book reflects the author's perspective on issues of importance to the preservation and health of the bus sector. The 21 chapters are edited versions of papers and reports written over the last 10 years, many of which have been published in journals and edited conference proceedings. Chapter 16 on a new costing regime for non-commercial contracts has not been published previously. It was developed for the New South Wales (NSW) Bus and Coach Association (BCA) as part of a regulatory review. The decision to compile this volume was based on an opportunity to showcase much of the recent research output on bus transport economics, policy and planning that has been produced by the Institute of Transport and Logistics Studies (ITLS) and to offer a one-stop snapshot of many research themes that remain current on the agenda's of public transport regulators, planners, operators, researchers and educators.

In preparing this document, I have selected papers that cover the themes of institutional reform, performance measurement and monitoring, service quality, costing and pricing of services including commercial and non-commercial contracts, travel choice and demand, integrated bus-based systems (referred to a bus rapid transit, busways, transitways) and public transport policy, especially challenges in growing patronage.

I have been privileged to work with many fine researchers who have contributed to the earlier versions of many of the chapters. I am indebted to Phil Bullock (Chapter 15) Rhonda Daniels (Chapter 13), Erne Houghton (Chapters 4 and 7), Rosario Macario (Chapter 2), Graham Pointer (Chapter 16), Paola Prioni (Chapter 14), Brett Smith (Chapter 11), Neil Smith (Chapter 18), John Stanley (Chapters 6 and 9), Peter Stopher (Chapters 12 and 15), John Taplin (Chapter 11) and Tu Ton (Chapter 12).

I also wish to thank the many researchers who have provided an opportunity for dialogue on the many issues discussed in this book. In particular, I acknowledge the support of Stephen Potter, Erik Carlquist, Odd Larsen, Nils Fearnley, Stephen Lucas, Michael Apps, Tom Parry, Tim Raimond, Jenny King, Bill Greene, Sergio Jara-Diaz, Chandra Bhat, Ian Wallis, Jordan Louviere and Joffre Swait.

The BCA of NSW under a Quality Partnership with the ITLS supported much of the research in the late 1990s and through to 2006. I am especially indebted to Darryl Mellish, Jim Bosnjak, Keith Todd, Tony Royle, Robert Hertogs, Stephen Rowe, Peter Threlkeld, Frank Dapuzzio, who encouraged and financially supported the partnership between ITLS and BCA as an opportunity for academia and operators to work together to promote serious research and help in increasing the understanding of this important sector to the transport task. While we have often been a challenge to the regulator, we believe that the research presented in this volume has made an important contribution to the debate on the role and relevance of the bus sector.

This page intentionally left blank

CHAPTER 2

ORGANISATION AND OWNERSHIP OF PUBLIC TRANSPORT SERVICES*

2.1. INTRODUCTION

The land passenger transport sector continues to undergo noticeable changes in the structure, performance and ownership of the organisations providing services to the market. These changes can be viewed from two perspectives: the relatively narrow focus on service delivery ('the operational' focus) and the broader and more holistic domain of system-wide performance (the full spectrum of strategical, tactical and operational foci). The former is best represented by the accumulating experiences associated with alternative models of exposure to market forces (economic deregulation, competitive regulation (or what is referred to in Europe as 'controlled competition'), monopoly, oligopoly), and ownership in its various guises (private and public with the former diversified to various levels of government). The latter focuses on ways in which full integration of land passenger transport (and public transport in particular) contributes to the economic, social and environmental goals of urban performance as implemented at the strategic, tactical and operational levels.

This paper is a summary of a workshop that sought to add to our understanding of the synergistic capability of these organisational themes and to identify ways in which the benefits of injecting the competitive ethic within the more holistic framework, as is being promoted (albeit cautiously) in Europe through proposed revisions to regulation 1191/69,[1] can deliver an improvement in the 'fitness of the system' rather than assessing the gains from the more narrowly focused (albeit still important) operator perspective. This emphasis is likened to the notion of the organisational supply chain in which clear gains can be achieved for the system as a whole through a closer integration (alliance or co-ordination, in the strict sense of taking

*This chapter first appeared as an article in the *Transport Reviews*.

concerted actions towards the achievement of a common objective) between the interdependent elements of the full life cycle of performance delivery.

In this chapter, we also highlight specific issues that help to improve our understanding of specific organisational reforms and ownership profiles that add to or detract from the fulfillment of the two perspectives above. We also offer a set of recommendations that contain actionable items for research and policy agendas.

2.2. ORGANISATIONAL REFORM DEVELOPMENTS

The organisational framework developed by researchers such as van de Velde (1992, 1997, 1999), Viegas and Macário (1997, 2001) as synthesised in Macário (2001) offers an attractive setting within which to evaluate mechanisms consistent with an holistic (of system-wide) perspective on service delivery. The main features of the framework (given in more detail below), are represented by three levels:

- The *strategic level* where the focus is on the establishment of broad goals and objectives and guidance on ways of achieving outcomes consistent with such goals ("what do you want to achieve" – Van de Velde, 1999).
- The *tactical level* which highlights the supporting mechanisms to achieve the strategic goals.
- The *operational level* which focuses on delivering the desired services to the market consistent with the strategic intent and aided by tactical mechanisms.

The strategic tactical operations (STO) framework provides the context in which we can put to test the reforms that to various degrees support mixtures of the Napoleon and the Anglo-Saxon codes[2] on delivery of services to the market and the community at large. Economists describe this mixture as the ability to deliver social welfare maximising outcomes under conditions of cost efficiency that can still support stakeholders in the supply chain whose pricing objective is profit maximisation (i.e, strictly commercial). Regardless of policy objective, a necessary but not sufficient condition is the provision of a *given level of service* at the lowest cost.[3]

Since the mid-1980s when the debate on potential instruments for reform began (with active implementation in some countries, notably UK and New Zealand), we have witnessed a smorgasbord of initiatives varying from a reinforcement of the status quo (principally, public sector monopoly) through to open market competition. The most popular initiative has been competitive tendering (CT) with a variety of contract specifications ranging from early incentive incompatible gross contracts (e.g., London in the late 1980s – see Toner, 2001) through to the more recent innovative incentive-based contracts as in Hordaland County Norway (see Larsen, 2001). At one extreme we had the Anglo-Saxon model where the focus was on the operational level and cost efficiency and effectiveness (with relatively little emphasis on service levels except in the preservation of the existing levels as defined variously by delivered vehicle kilometres or hours and passenger trips). Here the links back the holistic interest in system-wide gains, value for money and other terms for social welfare maximisation (SWM) and optimal subsidy profiles were extremely blurred to the extent that commentators felt that the model had abandoned SWM except in so far as gap-filling contracts were awarded to preserve the status quo in markets not capable of delivering commercial services. The other extreme is best exemplified by the French position (Code-Napoleon), in which organisational reform meant the 'principle of authority initiative' (Thome, 2001) which gave stronger powers to regional and local government to decide where CT may be introduced and where government authorities would continue to provide services directly or through their own protected companies. With rare exception, subsidies continued at a high level and collateral effects such as X-inefficiency accrued, with public companies in particular. The implicit commitment to SWM drives this agenda. In the last two years we have seen a blurring (or some might say coalescing) of the boundaries between these two extremes as the Anglo-Saxon model recognises the deficiency in service levels and the Napoleon-code recognises opportunities for subsidy reduction without forgoing the argued benefits of a more holistic regime as captured by the STO paradigm. The popular CT approach is thus justified by the aim of overcoming the pitfalls of the two extreme models (Napoleon vs. Anglo-Saxon).

What has now become a very real challenge, however, is establishing appropriate ways of integrating the intent at the three levels of the holistic 'plan'. In a very real sense, this is at the heart of the current debate on reform in Europe as each member country starts from a different institutional/market base and manoeuvres for a position that is politically acceptable. There are two generic models:

- A facilitation partnership between all stakeholders in the STO supply chain, identifying the gaps between enablers and processes and moving the exclusive foci on the operator to a more holistic focus, under which individual and aggregate performance (system performance) should be assessed.

- Establishing sufficient 'freedom' in the operator's contract to deliver the best to the community (i.e., a performance/incentive-based contract structure) where one taps the operator expertise as revealed in their market actions through incentive-driven service improvements. This can be achieved under both commercial and non-commercial delivery regimes.

The last two decades provided evidence around the world that within the limited (or controlled) competition approach, net cost contracts have the right ingredients to become the first choice for formal relationships between authorities and operators. Specification of service was possible, as well as control through incentives, while leaving room for operators to innovate their services and make it more flexible and responsive to market needs. Grounded in these beliefs we have seen the public transport world moving from highly regulated environments to the choice of economic deregulation, and more recently to compromise solutions of light-touch regulation aiming to control market concentration trends.

Yet many challenges remain: public transport is still loosing market share; congestion is worsening in big cities; citizens are becoming more informed and raising their voices against a public management that keeps mobility systems far below their needs and expectations. Consequently, political support to finance mobility issues is reducing. Although efficiency in production has been on the agenda for a long time, efficiency in consumption has been left for a second-level priority. Most notably, recent years have revealed some pitfalls of CT procedures hindering and challenging the so-called 'best choice'. These concerns include the following.

(i) The dominant position of operators through possession of market information,
(ii) The impact of contracts on the general contestability of the market,
(iii) The duration of contract versus ownership of assets at the terms of the contracts, in particular where high capital intensity exists (e.g., railways), and
(iv) Authorities' degrees of freedom in the design of the second tender and/or changes in the network design during the term of the contract (see Viegas & Macário, 2001).

A main component of the systemic (holistic) approach to mobility lies in the organisation of the system at the tactical level of decision to tap the STO supply chain gaps in a way consistent both with the more generic goals strategically defined (closely in line with the SWM approach), as well as with an effective monitoring of performance outputs.

The complexity of this holistic framework starts with the definition of strategic objectives where, for each local environment, decision makers are expected to achieve the most appropriate balance between transport, environmental, economic and social constraints and dimensions. Another barrier to overcome is the consistency in the translation of these objectives into service specifications, and finally the capacity to monitor them.

An essential feature of this holistic framework is the notion that a necessary condition of any system is to address the interaction of its main components (their fitness). For this, performance monitoring has to involve two complementary dimensions: the individual assessment of performance output provided by each agent and the aggregate output of the system. The first has been usually addressed through cost-efficiency approaches, evaluation of policy effectiveness, etc. For the second a more complex and demanding approach is needed in order to accommodate the following dimensions (Macário & Viegas, 1999) assuring the coherence of the system along the STO framework (decision or planning levels):

- *Industrial performance*, covering the transformation of basic resources into transport production (vehicle kilometres, VKM)
- *Network organisation*, covering the correspondence between those units of transport production (VKM) and the accessibility levels in the various parts of the territory served, and generally with the strategic goals of the system
- *Commercial performance*, covering the potential represented by the accessibility levels into real consumption of public transport by its clients (passenger kilometers, PKM)

Evidence provided through research in several European projects[4] leads one to conclude that the design of the transport system, with the integration of the different modal sub-networks, is a determinant for the global performance of the system, and is strongly conditioned by a number of decisions taken at the tactical level, in particular the ones related to the following variables (Macário, 2001):

- Internal variables
  - Legal possibility of having a plurality of initiatives in the market (i.e., degrees of freedom) and entrepreneurship for those initiatives (i.e., who takes the initiative)

  - Degree of competitive pressure and incentives in the system
  - Level of technical competence of the interacting agents for planning complex networks
- External variables
  - Political-administrative organisation of the country/region
  - Regulation externally imposed (valid for European Union frameworks only)

It is thus the setting up of processes to control integrated planning, contracting of operators and other services, monitoring and control, enforcement and evaluation, that will allow mobility systems to fill the current gap within the STO framework and between the several interacting institutions (as illustrated in Fig. 2.1).

Mobility issues are quite sensitive and continuously subject to the changes in domains exogenous to the system itself, such as the case for land-use and fiscal issues. The workshop discussion supported the idea that there is no universal recipe or best system to recommend. However, there is also a clear awareness that mobility should be viewed as a dynamic system with several interaction levels affecting different agents and different policies, where flexibility to enable adaptation to internal and external changes is of the utmost importance. This flexibility to cope with dynamism can only be assured through the set up at the tactical level.

It has become clear over the years, despite all the developments to improve efficiency of operation, that something was left behind – the global picture, the notion that mobility is, above all, provided through a supply chain. This particularly refers to the symbiotic concept embedded in

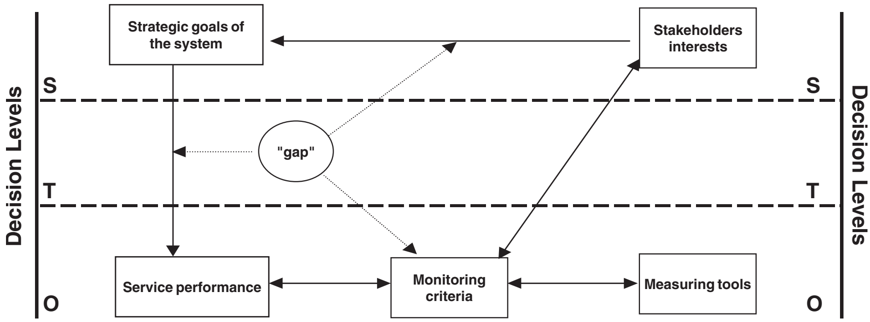


Fig. 2.1. Structural and Organisational Coherence of the System. *Source:* Macàrio (2001).

the holistic approach proposed, which recognises that no institution is able to act without affecting the other agents in the system. Social welfare maximisation principles applied to transport suffered as the focus was narrowed to the detail of cost efficient operations, losing to a growing extent the SWM aim associated with the overall mobility system. An emerging consensus is that the way forward must focus on the integration of SWM and commercial objectives in a way that delivers much improved service levels as part of a value-for-money objective function (see Chapter 7). This is likened to a return to the social 1970s (in Anglo-Saxon settings) in respect of the holistic vision but with a wiser view and commitment to commercialisation objectives and opportunities under a cost-efficiency regime (recognising the real meaning on optimal subsidy).

2.3. OTHER ISSUES

Some specific issues associated with the changing organisational and ownership structure of public transport that need careful attention to support the overall intent of the STO framework are presented below.

2.3.1. Market Concentration

In recent years in the rail, bus and ferry sectors in a number of countries (e.g., Britain, Norway and The Netherlands), the increase in market concentration has been a noticeable development. The most striking evidence is provided for the rail sector in the UK by Roberts (2001). The 25 rail franchises let between 1995 and 1997 were, by June 2001, in the hands of only 11 different franchisees. Similarly, as of September 1999, the bus industry market by turnover in the UK had 68% share in the hands of five groups (FirstGroup, 22.95%; Stagecoach, 16.39%; Arriva (including MTL), 15.7%; Go-Ahead, 6.52%; and National Express, 6.26%).

The factors that have driven business consolidation in the British bus sector (as per Roberts, 2001, citing TAS, 1999) include

- The latent instability of many companies, especially those formerly owned by the Scottish Bus Group and the Passenger Transport Executives following initial privatisation.
- The ageing of many of the individuals involved in buyouts, accompanied by the pressure of work during the intervening period and an opportunity to cash in on their investment.

- The significant advantage of major groups over larger companies, particularly purchase economies of scale, the use of modern technology to effect savings and changes in employee conditions.
- The financial structure of fledgling management/employee buyouts, particularly their own reliance on loan capital and subsequent difficulties with funding new investment.
- The desire of established groups to be seen by the stock market to increase their turnover and profit, which in an industry where organic growth is virtually non-existent, must be achieved through acquisition.
- The need for companies seeking stock market flotation to prove their worth to potential investors by expansion and to buy while other companies were still available.
- The long-term advantages in capturing a market in a region.

Further consolidation has been implicitly discouraged by the competition authorities; this has, in part, led to the diversification into other sectors described in Section 2.3.2.

Although the circumstances were somewhat different to the airline industry, the concentration outcome is very similar. That is, competitive forces had an initial implosion (be it for or in the market) encouraging active participation as 'potential' for reward is seen as high. The mixture of enthusiasm, investment backing and growing evidence of a range of economies of scale (notably of network, vehicles and finance) have had predictable outcomes. de Weger and de Jong (2001) report on reform in the bus industry in The Netherlands (Zwolle) where three operators were invited to replace a hitherto public monopoly operation (Arriva, Connexion,...) as part of preparing the way for competitive tendering. Although this invitation strategy might be seen as unusual (why not commence tendering immediately?), the Dutch view was that there would be only a few operators supplying services and that we should invite them to get familiar with the market. This is an interesting perspective premised on an assumption that the process of consolidation can be removed by selecting the likely candidates and anticipating that under CT the outcome would be essentially that of incumbency. A real risk in this approach is that CT will not occur and so this (partial) market test is lost.

2.3.2. Cross-Modal Ownership

> Although not exclusively, cross-modal ownership has been driven by Stock Market pressure for business growth more than any other factor (Roberts, 2001, p. 1).

An argument for cross-modal ownership, where the modes are thought to be complementary (e.g., feeder buses to rail systems), was raised as a basis of supporting the involvements of bus companies in rail service franchises. If this ownership profile enhanced the network benefits then the economies of network integrity argument can work in favour of this interpretation of market concentration. Roberts reviewed the situation in the United Kingdom and concluded that cross-modal ownership appears to have had no noticeable effect on the ability to deliver improvements in multi-modal travel involving buses and trains. Although argument on this single piece evidence suggests that cross-modal ownership is not a strategy to deliver improved services consistent with the objectives promoted under S and T in STO, the case is still out internationally.

2.3.3. Monitoring of Performance

An essential and often poorly constructed and resourced input into the delivery of cost-efficient and service-effective services is a monitoring programme. We need to learn from the active experience and have a transparent framework in place to ensure compliance under whatever delivery regime is in place. Monitoring is often neglected. It is not clear in most circumstances who should pay for it, who should do it and how the outputs should be used and maintained for easy access. Toner (2001) raises concerns about this in tendering in the United Kingdom. Monitoring costs should be internalised in the contract price to secure the funding for this vital activity. Although monitoring costs should not be determined by the bidder, there should be a fixed sum agreed to by the tendering authority. In addition, a process of monitoring should be clearly documented with obligations of all parties set out.

2.3.4. Growing the Human Skill Base

A critical input into the successful delivery of services within the STO paradigm is human capital. Expertise in a number of areas has been waning in recent years as the task set changes. Of particular concern is the knowledge base of the regulator whose job definition has changed substantially with the opening up of markets. The gap between operational and tactical knowledge in particular has been widening, leading to a major concern about the ability of the regulator to do their job properly with such a limited expertise base. This might be rectified in part by quality partnerships or transfer of tasks under a strict regime of monitoring; however, the risk of regulatory capture must be taken seriously.

2.4. RECOMMENDATIONS FOR ONGOING CONSIDERATION

1. That we recognise the market knowledge of the operator and ensure it is internalised in the service delivery process throughout the STO framework and not jeopardised by regulatory imposition.
2. That all organisations involved in the STO process commit resources to establish appropriate incentives to grow the skill base of human resources that has eroded in recent times. This is especially a concern in the regulatory agencies.
3. That monitoring schemes properly resourced to ensure that information is captured that enables us to identify the success of a particular service delivery model and that compliance with contracts etc. is satisfied.
4. Quality partnerships in the STO framework provide one real test of a commitment by key stakeholders to act as interactive agents for the common good.
5. The STO framework promotes the assessment of service delivery in terms of 'value for money'. This can be achieved through the SWM objective while still supporting a profit maximisation (or at least a commercial outcome) for the operator. Incentive-based contracts such the Hordaland contracts show great potential in compliance with STO.
6. That SWM objectives have to be brought back to the system level.
7. That mobility is a symbiotic system where enablers, processes and expected results, should be setup in a framework consistent with the strategic goals that provides the adequate interaction mechanisms for intervening institutions.

CHAPTER 3

USER NEEDS AND IMPACT ON PUBLIC TRANSPORT†

3.1. INTRODUCTION

This chapter discusses user needs and the linking of such needs to alternative supplier environments, especially competitive tendering (CT). A theme throughout this chapter is service quality, in part a derivative of the concerns in Britain since the impost of greater market influence and the decline (perceived or real) in passenger satisfaction. The challenge is to consider how international experiences on performance of public transport (and its monitoring) could be used to the benefit of specific countries where there is a substantial amount of public passenger transport delivered by the public and the private sector, in a mixture of 'formal' and 'informal' ways. We address the complexity of informal transport service delivery and the risks of formalising it, in the sense of imposing such strong regulation that its contribution is minimised if not eliminated. Mimicking the supply of public transport in mature economies by very flexible public transport (some might say wasteful and unregulated; e.g., Matata's in Kenya and mini-bus taxis in South Africa) may not be a good idea. Instead, the preservation of such flexibility under a more efficient delivery system may be the saviour of public transport, as the wealth of such economies creates the inevitable clamour for automobile ownership and use. The opportunity to avoid the mistakes of mature economies that have regulated the delivery of flexible public transport that satisfies customer needs better than any other must not be lost. Trying to reverse the decline in public transport use is the curse of mature economies.

†This chapter first appeared as an article in *Transport Reviews*.

3.2. SERVICE EFFECTIVENESS IN DIVERSIFIED MARKETS

The literature on measuring the cost efficiency and cost effectiveness of public transport services and operations is extensive (e.g., Hensher & Daniels, 1995; Fielding, Babitsky, & Brenner, 1985). A major data input is the level of service output, typically measured on the demand side by annual passenger trips or passenger kilometres and on the supply side by vehicle or train kilometres. As aggregate indicators of total output, these measures implicitly assume homogeneity in respect of service quality. Passengers however evaluate services in many ways, not always systematically associated with the amount of use of the service. Indeed it is unclear whether differences in passenger satisfaction across the segments served by buses can be replaced by the preferred demand side indicator, *aggregate passenger kilometres*.

Although specific aspects of perceived service quality may be particularly positive or negative, we argue that the overall level of passenger satisfaction is best measured by how an individual evaluates the total package of services on offer. Appropriate weights attached to each service dimension will reveal the strength of positive and negative sources of overall satisfaction. The stated preference (SP) paradigm is promoted as the most appealing way to develop preference formulae for a large number of service-level scenarios, which can be implemented at the public transport business level to establish operator-specific indicators of service delivery quality and effectiveness. The resulting satisfaction (or utility) indicators emanating from the estimation of the SP experiments measure the expected utility that a passenger obtains from the current levels of service and how this might change under alternative service-level regimes.[5] Prioni and Hensher (1999) have developed such an indicator known as the service quality index (SQI) (see Chapter 14 for more details).

SP studies however have to be carefully structured to be useful. Such techniques have value and can work even in contexts where one is seeking preferences from ‘immature survey markets’ such as a rural setting in South Africa. Even two attributes being traded like safety and fare is a useful start. Clark (1999) provides a review of SP work undertaken in South Africa. In SP studies one has to take into account complexity, comprehensiveness, the range of attributes, attribute levels and reality. On the latter, we must avoid a false sense of delivery. We must also avoid policy response bias. See Louviere, Hensher, and Swait (2000) for further details.

In many countries the focus is not so much on understanding user needs in situations of modal choice but on studying user preferences where individuals are captive to a modal context (especially public transport including mini-bus taxis) and where no motorised modes exist at all.[6] In understanding situations where we have no motorised transport or where people are captive, there is a further challenge of how one might collect such data on preferences given the absence of any (or little) prior experience with the survey process. Distrust (why do they want to know my preference?) and learned helplessness (uncontrollable events lead to perceptual errors and behavioural deficits) (Seligman, 1975) are both common features of the survey process. The latter also applies to mature survey contexts that can lead to apathetic replies. One needs to work closely with local groups who understand local culture and languages and of a similar socio-economic background to those from whom we seek preference data. This is the barrier reduction challenge. We need to create an interest in wanting to participate in user-need surveys in many developing economies.

Given issues in developing and even maturing, survey contexts such as captive users, low literacy levels (van der Reis, 1997) or a lack of experience with SP surveys, then it is very likely that great care and effort should be spent on collecting reliable information about the context within which people make current travel choices. It is on this basis that we can use the following:

- identify the set of attributes which need to be considered (probably the fewer the better),
- select the measurement unit for each attribute,
- specify the number and magnitudes of attribute levels, and
- decide how best to present SP survey instruments.

Information-rich (and hence expensive) methods such as panels and focus groups are likely to have an important role to play in collecting appropriate contextual information. Given the heavy resource requirements of these methods, the trade off is likely to be one of higher quality information from smaller samples, rather than extensive surveys using less-intensive information-gathering methods.

3.3. QUALITY PARTNERSHIPS

Quality partnerships are heralded in some countries as an opportunity to share the cost of delivering services in line with user needs. In the British experience, ‘competition’ is an appealing mechanism to increase service effectiveness and increase consumer satisfaction. It can be achieved in many ways such as by strategic alliances between bus and rail maintenance, and between the formal and informal sector operators. This latter mix is of interest in maturing economies such as South Africa where contracts between the formal and informal sector can enhance the spirit of seamless transport. In recent bus and rail contracts in South Africa, for example, there is a requirement for the formal sector as contract recipients to subcontract a number of services to the informal sector, presumably as part of a government initiative to take advantage of the relative strengths of each sector (e.g., mini-bus taxi vans linking to commuter rail).

3.4. SERVICE EFFECTIVENESS AND CONTRACTS

Over the last two decades the public transport industry in many countries has been involved in a process of economic deregulation, competitive regulation and privatisation. Among the different policy practices designed to increase competition, CT represents a widespread policy intervention. Although there is extensive acceptance of competitive tendering, the focus has been on cost efficiency and cost effectiveness designed to identify the mix of inputs used to produce a given level of output at the lowest cost, where output is produced services (e.g., vehicle kilometres) on the efficiency measure and consumed services (e.g., passenger kilometres) on the effectiveness measure.

Regulators have been singularly unsuccessful in developing a robust specification of service-quality levels, and have come into criticism that the focus of economic reform has concentrated too much on saving money at the expense of preservation and enhancement of service levels. The definition of service level has tended to ignore the quality of service, limiting the specification of a predetermined level of service to simple physical measures such as vehicle kilometres and passengers carried. This gap in the tendering process denies potential bidders the opportunity to prepare their bid offers with full knowledge of the effectiveness of existing service levels (Domberger, Hall, & Ah Lik Li, 1995; Van de Velde & Sleuwaegen, 1997).

The integration of service effectiveness into the specification of contracts for the delivery of public transport services is important. The majority of tendered contracts throughout the world do not include a user-derived set of measures of service quality; rather they use proxies such as the timetabled delivery of vehicle hours of service together with conditions such as maximum age of buses or rolling stock.

The SQI index proposed by Hensher (see Chapter 14) provides an appealing index to compute and operationalise service quality from a user perspective in an easy and scientific way. Because of its simplicity and its

Table 3.1. Including SQI Targets in the Contact Design.

Operator	Current Service Description						SQI	
	Attributes						Target after	
	Reliability	Bus fare	Clean enough (%)	Travel time (min)	Etc…	Realised	2.5 years	5 years
1	2 min late	2.1	60	25	…	1.4	1.6	1.8
2	1 min late	2.4	78	26	…	1.3		
3	1 min late	2.0	80	21	…	2.0		

ability in capturing important user-defined service quality component in a single index, SQI is a preferred operational tool in the specification of tendering contracts. SQI makes explicit through the revelation of information on current service quality, the requirement to take into account the cost of maintaining and even enhancing service quality in bid offers, minimising the selection of low bids accompanied by low service quality delivery.

Table 3.1 gives an example on how one might integrate SQI targets into the tender process. Let us assume that from a survey of a sample of existing users, we have identified the user-defined quality of current service of three operators. Operator 1 achieved an SQI of 1.4 by providing a service that is on average 2 min late, clean enough for 60% of the sampled users, costs on average $2.1, etc. Operators 2 and 3 have SQIs respectively of 1.3 and 2.0. Assuming that these operators are comparable, Operator 3 is best practice.

In South Africa, monopolistic bus operating conditions have existed in urban areas since about the 1940s. Urban areas also have vastly different characteristics with respect to key factors such as travel distances, topography, urban structure etc. So generally we have a situation of few and protected (except for competition from minibus–taxis) operators, each operating under usually vastly different conditions. Given all this it may be difficult to determine the best practice by comparing current operators. In these conditions, a slight variation in approach may be to establish an existing SQI for the current operator in each area and use this as the starting point from which service delivery must be improved upon. Alternatively, perhaps the SQI methodology could be used to develop a 'user quality charter' in each urban area to determine what people would accept as an effective transport service – although it would be important to take into account funding constraints to prevent unrealistic expectations. The SQI/user charter could then form the basis upon which tender specifications are developed.

Regulators can use the SQI in the contract design to specify how much service improvement they require relative to the current levels as illustrated in the last two columns of Table 3.1. Although one might impose the requirement that each and every operator must be at best practice, this may discourage bidders, and so we prefer to set a target level that is recognised as achievable by potential bidders. The level should be incentive compatible.

Given the gap between an operator's SQI and that of best practice (e.g., 0.6 for Operator 3), a revised formulation might be $SQI+z$, where z is the pre-designated improvement over a period of time (e.g., 0.2 in both sub-periods). The $SQI+z$ formula provides a target in line with a pre-designated increase in the service quality level. In the case of the service previously provided by incumbent Operator 1, authorities impose an SQI target of 1.6 after 2.5 years and a final SQI target of 1.8 at the end of the contract (5 years).

The required service quality level can be evaluated by bidders and added into the cost of providing the higher level of service to determine the bid price. The contract will be awarded to the lowest price offer (with the cost of service quality internalised). Once successful in winning the contract, the operator has a strong incentive to meeting the new levels of service. Compared to the traditional tender contract specification, the inclusion of SQI in the contract secures improvements in cost efficiency while meeting the new levels of service effectiveness as prescribed by a user-defined service index.

3.4.1. Monitoring and Responses

To ensure contract compliance the supplier must be monitored during the contract period. Assuming a contract length of 5 years we propose a performance assessment at the mid-point. An operator would have to conduct a user survey after 2.5 years to establish compliance. To avoid any disputes on who should pay for the survey, it makes good sense to include the monitoring cost as part of transactions costs of the bid and included in the bid price. Table 3.2 summarises the four possible outcomes of a contractual process.

If the operator is compliant, it becomes a political decision whether the contract will be renewed or re-tendered at the end of the contract period.

Table 3.2. Possible Outcomes of a Tender.

	Renewal	Retender
Compliant	End of the 5 years	End of the 5 years
Non-compliant	Retendered	Retender: (Warning after 2.5 years)

In the case of non-compliance after the first half of the contract period, the non-compliant operator should be warned about under performance without losing a contract. If the operator is unable to achieve the target performance by the end of the contract period, the contract should be re-tendered. In the case of a non-compliant operator, the tendering authority must determine if the reasons for non-compliance are internal to the contractor (i.e., under his control) or external (i.e., not under control of the operator). Only internal failure needs to be corrected through sanctions. In the case of external factors influencing the operator's service quality, the tendering authority should review the pre-agreed targets.

The extent of benefits from CT depends not only on the size of the targeted SQI (see previous section), but also on other factors influencing the amount of competition. The size of irrecoverable costs, the length of the contract and the perceived probability of success will be critical factors in determining how many bidders come forward. The provision of information on existing service quality levels of the incumbent is essential to the success of the broadened specifications of competitive tenders if potential bidders are to be forthcoming.

3.5. RECOMMENDATIONS

Eight key recommendations follow from the ideas given in previous sections:

1. Recognition of the need to commit more effort to understand user needs and preferences, especially in maturing economies (before we make the regrettable mistake of eliminating the very flexible informal sector). Importantly, this need not be a high-cost activity, an issue of particular concern to many developing countries.
2. Quality partnerships, as a framework within which to grow our knowledge base of user needs, are recommended. All stakeholders benefit from a better knowledge of user needs. Quality partnerships between transport operators and universities and between operators and local government are examples where both parties can benefit by the expertise and financial support of the other.
3. Understanding user needs is best fulfilled by properly controlled scientific sampling of actual users and potential users (e.g., systematic stratified random samples from the entire population). More focus on this is recommended. Note that pre-conditions will vary according to maturity of the population being studied.

4. In all contexts (mature, maturing and non-existent markets) close consideration of segments in recognition of the diversity of basic needs is required. We recommend early research and study of markets where the greatest potential for delivering basic and/or enhanced service exists. The idea of a broad-based user needs survey involves identifying who will be strong candidates for switching to public transport and which existing public transport users are at greatest risk of being lost from public transport as their circumstance changes.
5. Development of guidelines on the nature of data required, sampling strategies and data collection methods in situations where users/potential users have varying degrees of maturity/exposure to formal survey procedures. The importance of getting to know key players in immature markets – what we might call protocols of hierarchies to access a population (e.g., via a tribal Chief), focus groups, expert panels, matching of interviewers, etc.
6. Development of guidelines on how service quality should be measured and integrated into the design of a performance assessment regime (PAR). A SQI linked to benchmarking provides one appealing approach as detailed above. Such measures of service quality are applicable to protected monopoly markets, competitively regulated markets (i.e., competitive tendering) and deregulated markets. Where CT is the delivery mechanism we recommend that the cost of monitoring (and clear guidelines on its execution) should be internalised into the bid price to ensure that adequate monitoring is undertaken.
7. A greater focus should be placed on making very flexible public transport systems safer. Such systems in many developing economies already provide some of the best public transport. An important issue in the ‘informal sector’ is removing wasteful competition as a precursor to removing the violence in service delivery (e.g., the taxi van industry in South Africa). The challenge is to remove wasteful competition without destroying the very fabric of benefits to users. The risk is that in doing so we create a rigid public transport system more typical of the ‘formal’ sector that is shrouded in regulation designed more to protect the interests of incumbent operators than the interests of users/potential users. However, in the long run this even impacts negatively on incumbent operators by destroying the market opportunities and results in escalating subsidy. The USA is a good example of this. The solution to this problem could well be to focus regulation efforts more on the *quality* of public transport rather than on the *quantity* aspects, i.e., to identify key quality-related performance indicators to be met such as safety, affordability, etc. rather than being overly concerned about the mode and amount of transport supplied.

8. A greater focus on the training of managers in the public transport industry (especially operators) in order to understand and appreciate the need to know their market of customers. To know your market is to know your business.

This page intentionally left blank

CHAPTER 4

CONTRACTING OPTIONS

4.1. INTRODUCTION

> Performance Based Contracts, or any contract for that matter, will not work successfully without a trusting quality relationship between government, regulator and operators (Hensher in workshop report to plenary session, September 17, 2003).

The last 20 years have witnessed many applications of a diverse array of regulatory and institutional reforms designed to deliver improved public transport services. Using a wide range of explicit or implicit objectives (e.g., reducing government subsidy, providing value for money, ensuring cost-efficient service delivery …), a great deal of experiential evidence on the relative merits of reform models that promote elements of competition in land passenger transport (especially bus and rail) has been accumulated.

Central to the many market applications has been a 'contract' (or right-to-provide services) of some form, ranging from a loose registration in an economically deregulated setting (with new roles for the regulator), through competitive regulation (especially, through tendering and franchising for a defined period).

One of the most discussed issues of the reform process has been the search for evidence on how successful previous initiatives relating to ownership and contracting of the public transport planning, development and service delivery functions have been and whether refinements might provide better outcomes. Competitive tendering (CT) has shown itself to be a relatively popular instrument for change. However, as time passes, a number of deficiencies in the CT processes implemented to date have emerged, raising questions about where this approach is most suitable and the ways in which it is best applied. Some of these deficiencies are attributable to the inadequacy of the regulatory framework within which CT is delivered and monitored (although the amount of monitoring is usually disappointingly limited) and some are due to the nature of CT. Relevant examples of these deficiencies include the following:

(a) While we can cite some substantial gains in cost reduction from CT, these often show themselves as once-off gains in the initial round of tendering. There is also evidence of significant savings from corporatisation of previous public monopolies (e.g., Toronto, Dublin and Sydney and Melbourne, as documented in Chapter 9), suggesting that CT may be a sufficient but perhaps not a necessary condition for delivering such savings although the evidence would tend to support the view that larger and earlier savings generally result from CT and other forms of direct competition.
(b) A supplementary role of CT is to serve as an instrument for radical change in service delivery (e.g., the replacement in Santiago Chile of 4,000 bus operators (with 8,000 buses) with 15 operators). Subsequent re-tendering delivers very little gain in a financial sense[7] and indeed in situations where a large number of small operators in the informal (or alternative) transport sector as in Brazil are replaced by a few larger operators, the costs of service delivery under CT may increase.[8] Although there is an element of this in South Africa, Nash and Walters (2005) argue that the main reason for the cost uplift was improved vehicle specifications that brought the average age of the conventional bus fleet down from 12 to 6 years. The tendency for numbers of bidders for re-tenders to decrease in some countries suggests that this issue of the sustainability of initial cost savings may become widespread.
(c) The accumulating uncertainty of the re-tendering process often restricts investment and innovation, with operators typically limited to complying with the minimum requirements.[9] Preston (2003) suggests that this will be mitigated by the emergence of global players, for example, Arriva, Connex; whereas Stanley and Hensher (2004) argue that these players practice market sharing which is anti-competitive.

Such issues are leading to an examination of negotiated contracts (NCs) (performance-based contracts, PBCs) as an alternative (and/or sequenced complement)[10] to CT as a means of allocating rights to deliver public transport services. Negotiated contracts are common in public–private partnerships in the infrastructure area but are much less so in public transport operation.

An over-riding issue eloquently stated by Preston (2003) that guided our discussions is that contracts (in general) should strive to comply with the following position:

> Too little change results in system ossification, too much change results in transitional costs (including transactional and coordination costs) that will outweigh any benefits of change.

The arguments developed herein start from the position that all rights to provide public transport service (expressed through contracts) should be dependent on the performance of the provider and that this should be expressed through a performance-based contract, in the broad sense. We take a close look at the nature of performance-based contracts and the issues that need to be dealt with in developing contracts that most effectively meet a government's objectives in public transport service provision.[11] In particular, we focus on the relative merits of NCs, compared to competitively tendered contracts, in delivering value for money outcomes. We seek to establish a framework within which both competitively tendered and NCs can be represented as a class of contract within the general model of PBCs, recognising that both classes of contract can and do exist without any performance-linked specifications.

4.2. DEFINITIONAL ISSUES FOR PERFORMANCE-BASED CONTRACTS (PBCS)

An effective contractual regime is one within which the government (S: strategic), the regulator (T: tactical), the operator (O)[12] and society at large can participate as 'trusting partners' in securing value for money in (i) the allocation of a total subsidy budget to the provision of services or (ii) in the delivery of non-subsidised services.[13] Within such a contractual regime an operator provides services (be it designed at the 'T level' or integrated at the 'O level') at *best practice cost levels* (however determined) for a given level of service delivery either:

(i) in return for direct financial (social) support from government (i.e., a social subsidy which may be awarded by either CT or negotiation) or
(ii) in return for permission to operate a negotiated/agreed level of service (without subsidy but, for example, subject to a cost-plus fare determination).

Within such a contractual regime, PBCs are characterised by a payment structure involving:

(i) a fixed payment (e.g., a community service obligation ($CSO) payment linked to a minimum service level (MSL) programme determined by negotiation or CT or a partnered service design and level,) and/or

(ii) a set of incentive payments above the fixed payment linked to patronage and/or service levels (e.g., vehicle kilometres, frequency by time of day …).

A further characteristic of PBCs is that the incentive payments linked to patronage and service growth reflect both benefits derived from all sources (i.e., consumer or user surplus) and additional benefits specific to reducing car use (or more broadly reducing negative environmental impacts). Those linked to service levels may also incorporate a mechanism for supporting new entrants into developing markets (as in South Africa, for example, under the empowerment policy). Patronage incentive payments (PIPs) may be based on various criteria (e.g., passenger boarding and passenger kilometres to account for the trip length distribution as well as the actual number of passengers).

Fig. 4.1 shows the contractual components that bind the strategic tactical operations (STO) entities together.[14] Although the maximum fare is on the laissez-faire side of regulatory processes, while social support presents many contract specification challenges to effectively promote goals consistent with strategic objectives, all contract components can apply to all contract types.

In discussing the roles of CT and negotiation in the specification of a PBC regime, it is useful to distinguish between the basis for procuring the operator and the basis for paying/rewarding the selected operator. A number of combinations of procurement and payment strategies can be devised from this simple dichotomy, as summarised in Fig. 4.2. Most commonly, the payment model (and all other contract conditions) would be defined in advance by government; and then the operator selected through CT or a negotiation process. However, CT and NCS can be complementary in a temporal sequence. For example, one can use a service incentive payment

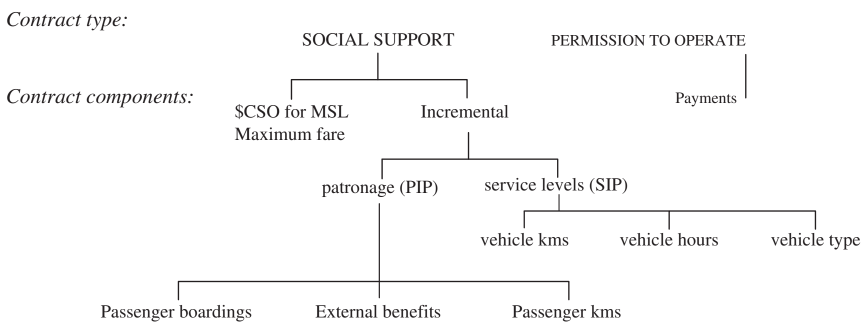


Fig. 4.1. Contract Components.

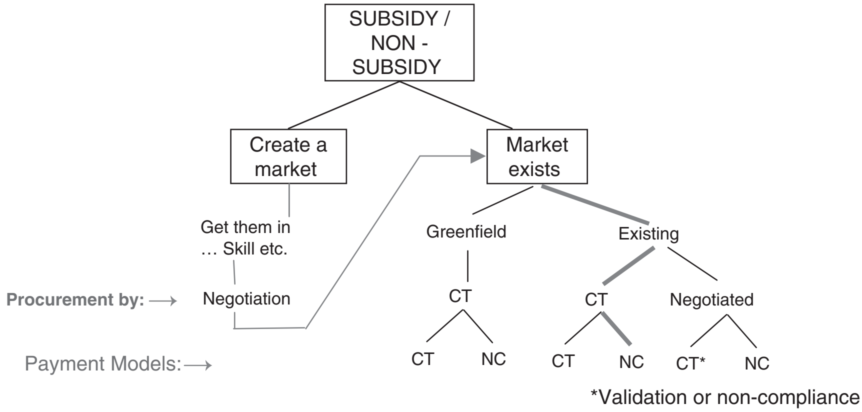


Fig. 4.2. Processes for Procurement and Payment Rates Determination. *Note:* (i) A Greenfield Site is Different to 'Creating a Market'. The Latter is More Global in its National Context and Refers to a General Absence of Expertise That Can Readily Participate in the Market, be it an Area Already Serviced or a New Development with no Services (i.e., a Greenfield Site). (ii) The Block under Greenfield, Could Also be Negotiated. For Example, in South Africa (e.g., Durban) an Expression of Interest for New Services is Common Which is Not Subject to CT.

(SIP) under a NC to assist new entrants into new markets (including a base $CSO) perhaps with training/skill enhancement support.[15] When a market is established (given sufficient elapsed time – e.g., 5–10 years) one might introduce a PBC via CT to rationalise the number of 'competing' operators in a corridor (as is proposed for Santiago, Chile – see Appendix 4A of this chapter) or select an individual operator at a route or corridor or area level; or, one might move to a PBC regime via a NC system. Alternatively, a government might use CT to short-list a number of suppliers with whom it then negotiates to select the preferred supplier.

Incentive payments can be introduced through CT or negotiation under a PBC regime. For example, one can establish a PIP of various possible types; for example:

(i) the Adelaide model (agreed non-competitive sum per additional passenger) and
(ii) the Hensher–Houghton model (see Chapter 7): with a fixed or variable PIP budget competed for among a pre-defined set of operating areas, which we may refer to as competition at the later service delivery stage, as distinct from at the tendering stage.[16]

Given that many factors affecting patronage are outside the influence of the operator, the appropriate level of PIP may be fairly modest; and this will then need to be supplemented by a SIP to provide the operator with sufficient incentive to expand services: the Adelaide model adopts this approach, and requires a tactical-level sign-off on service proposals. This SIP may be a marginal payment rate (as in Adelaide) or an amount competed for by operators who grow service from an agreed MSL linked to a base payment. The introduction of a SIP, where one does not compete for subsidy budget between operators in different spatial settings, is an appealing model for South Africa and also Brazil (the Brazilian model is shown on the right-hand side of Fig. 4.2 by the thicker line only).

A well-defined governance structure is required for PBCs to work best (a position also suggested by Preston, 2003). To be specific, in some countries there is a significant element of influence or even corruption manifested in various forms. For example, in Brazil we see the powerful influence of private bus operators (in the legal sector, in theory) who have been very successful in negotiations associated with cost-plus contracts (used in fare setting) in securing higher fares than are consistent with cost-efficient service delivery. The weakness of the regulator in establishing and implementing, through regulation, benchmark best practice costing, demonstrates the influence of information asymmetry as well as the power of private operators, as a group, over the regulator (the latter being a relatively low-paid public servant with limited resources).

4.3. PROCURING SERVICES THROUGH COMPETITIVELY TENDERED OR NEGOTIATED CONTRACTS – THE ISSUES

Within the generic PBC framework, a central theme is the extent to which CT has served its role well, but that there may be a growing role for NCs in circumstances where

(i) the financial gains from re-tendering are small;
(ii) the incumbents are efficient suppliers; and
(iii) a greater focus should be placed on innovation in service supply, growing patronage and providing some longer-term incentives for operators to invest in quality assets (especially in situations where there is an inefficient market for second-hand assets that adds substantial risk to retrieving the residual value of buses and coaches in the event of not having one's contract renewed).

CT and NC may have complementary roles. It is quite compatible for a given contract to determine the $CSO for an MSL through CT while determining a patronage growth incentive payment rate through a negotiation process (or by specification by the regulatory authority). The key requirement is that contracts have transparency and simplicity. This may be helpful in some cases where a legal requirement for CT may be satisfied by $CSO determination, leaving a level of negotiated contract or competition at the service delivery stage to determine payments for service/patronage improvements.

Negotiated contracts should be subject to benchmarked best-practice context-specific costs (that arguably approximate the CT outcome), with incentive payments for achieving specified growth in patronage and/or service levels. As noted above, these incentive payments could come from a pool of funds that is competed for[17] across operators within a contract set (e.g., a metropolitan area), as proposed by Hensher and Houghton (2003) and Hensher and Stanley (2003), for growth above a pre-determined minimum service and patronage level. The workshop discussed the major upsides and downsides of CT and NC relative to each other. This was the most 'heated' phase of the workshop, as participants sought to establish a position and clarity of argument in support of either CT or negotiations as a means of selecting the operator.

The following summarises the main features and merits of the CT and NC procurement approaches against a set of key contracting attributes:

4.3.1. Cost and Subsidy Impacts

- CT has been successful in delivering substantial and sustained cost reductions (up to 30–40%), but generally this relates to the first round of tendering of a public monopoly service (similar results have been obtained in other sectors in such situations).
- There is evidence that corporatisation together with budget constraints and the threat of competition, may also deliver substantial savings – although these would tend to happen more slowly and perhaps to a lesser degree than with CT.
- Evidence is accumulating of cases where some of the initial cost savings through CT are eroded through cost escalation in subsequent tendering rounds. Such cost escalation may reflect a variety of factors, for example, labour market trends, enhanced vehicle and service specifications, reduced competition, reaction to excessively low initial bids ('winners curse').

- While the evidence is sparse, there is little to indicate that negotiated contracts are likely to result in lower (or higher) subsidies than CT contracts.

4.3.2. Administration and Regulatory Costs

- CT involves significant administration costs to both operators and government/regulators. In addition, the transition costs to operators and to users (through service changes, uncertainties, etc.) may be considerable.
- However, NC may also involve significant transactional and co-ordination costs, particularly in establishing appropriate benchmarks and monitoring performance against these.
- CT may degenerate into an auction in the labour market, possibly leading to excessive wage reductions and the need for minimum wage level regulation.

4.3.3. Establishment of Appropriate Benchmarks

- CT establishes benchmark subsidy etc. rates through the competitive process.
- Under NC, 'benchmarking' and 'yardstick competition' approaches are used to approximate the results of the CT process. However, such approaches are imperfect (particularly in 'green field' situations) and may involve complex calibrations and extensive negotiation processes. As each bus network and area is different, fair treatment across all operators may be difficult to achieve.
- If comparisons among firms (i.e., yardstick competition), becomes systematic and operators under NC do not change, collusion around performance benchmarks may arise.
- CT is a necessary 'fall-back' option for government in the event that the negotiation process cannot be concluded satisfactorily.

4.3.4. Accountability and Transparency

- NC involves a less transparent process with greater danger of regulator capture.
- However, CT is not free from such dangers, as illustrated by the experiences with the Melbourne train and tram franchises.
- Under CT, the incumbent operator accumulates extensive market knowledge, much of which is not made available to the regulator. This may give the incumbent operator a substantial advantage in re-tendering.

4.3.5. Optimising Networks and Funding Allocation

- Networks subject to CT may be designed to maximise social surplus subject to a budget constraint, provided all the network is tendered at the same time; otherwise social surplus maximisation is problematic.
- Within a NC process (and possibly CT), it is possible to arrange competition between operators for a fixed incentive payments budget (for patronage and/or service incentives), over all levels of demand and service or above a pre-determined minimum level (as per the Hensher-Houghton (2003) framework in Chapter 7).
- This should ensure that competitive forces are at work throughout the life of a PBC, provided that the incentive scheme is an effective mechanism to deliver service improvements and active monitoring takes place.
- Experience under either CT or NC, suggests that regulators typically err on the side of caution and tend to let contracts based on previous services. However, with appropriate service review procedures during the contract term, subsequent changes may be initiated between the two parties – although arguably this is more difficult under the CT than the NC model.

4.3.6. Some Development, Performance Incentives and Monitoring

- Key performance indicators (KPI) and appropriate benchmarks are an important feature of negotiated contracts, since they form the basis for negotiation of contract renewal. The regulator must have a good knowledge of best practices, and cannot be dependent on advice from operators (note the situation in Brazil where fare adjustments have been based on cost escalation advice from the operators).
- Under both NC and CT, incentives may need to be large to influence operator behaviour. This may be a particular problem when available funds are constrained and have to be shared between multiple operators.
- There are weaknesses in approximating non-linear welfare functions with linear incentive functions. This could lead to over-shooting the welfare optimal level of service provision; although in practice such problems are likely to be limited by the various constraints in the system.
- Inadequate contract design (under either CT or NC) can result in perverse incentives, depending on the basis of reward, for example through encouraging empty buses, split routes, longer trips.
- There is a danger of setting targets too low (e.g., in cases where external factors prove favourable), and hence operators becoming complacent.

- Under NC, there is a danger that management effort will unduly focus on justifying their performance to secure contract renewal, rather than on genuine performance improvement.

4.3.7. Government-Funding Risks

- Incentive-based contracts (whether CT or NC) may involve significant budget uncertainty for government, associated with service-related or patronage-related incentive payments. However, the extent (if any) of this problem depends on the details of contract specifications. (e.g., under the Adelaide bus contracts, incremental patronage payments approximate to incremental fares income, leaving minimal patronage risk to government, while government has the veto on any proposed service changes.)
- The Hensher–Houghton payment model (which could be applied under CT or NC) can operate within a budget cap, being designed to encourage competition between operators for available subsidy so as to maximise social surplus per dollar subsidy.

4.3.8. Encouragement of a Strong, Diverse Supplier Market

- CT is likely to lead to periodic new entrants to the local market, and hence encourage innovative approaches etc.; while NC may tend to result in ossification of the supplier market.
- With suitable contract design, CT may be used to encourage the development of smaller and new operators, as well as provide roles for larger established and entrepreneurial operators (maybe from overseas).
- Under CT, there is some danger of excessive consolidation of the supplier market among a few large operators (with risks of excessive market power and possible collusion). However, this danger can be minimised by imposing market share (or equivalent) limits on any one operator in an area.
- CT may give excessive advantages to incumbents in the tendering process (e.g., through superior information, ownership of valuable depot sites, etc.), thus discouraging a strong supplier market. Such advantages can be reduced through appropriate contract specification.
- CT may be iniquitous under an empowerment regime such as in South Africa. Here it is desired to attract new entrants, to develop a market of reliable operators, while limiting the number through tendering (which will almost certainly discourage the smaller less-advantaged operator), and at the same time giving them a limited and uncertain future in a

volatile market. The transaction costs will be too high for too many operators. NCs may be even more iniquitous if they reinforce incumbency advantages; however, benchmarking of costs is designed to prevent this.

4.4. PAYMENT MODELS

One of the key features of any contract, whether procured through a CT or NC process, is the basis of payment to the operator. This payment basis will govern how the operator will behave over the life of the contract (e.g., so as to minimise costs, maximise patronage, etc.). Potential types of payment models include (see Wallis, 2003):

(i) Gross cost contracts as in Melbourne, London, many EU countries and others worldwide.
(ii) Net cost contracts (also known as bottom line or minimum subsidy) as in New Zealand, UK outside London, some in Australia, and in South Africa.
(iii) Gross cost plus patronage incentive contracts, which includes a fixed payment related to a minimum level of service plus patronage incentive payments (proposed in the Hensher-Houghton (2003) model with elements in Hordaland Norway model as presented by Larsen (2001) and updated in Berge, Brathen, Hauge, and Ohr (2003)). One important sub-category of these is sometimes referred to as 'economic-based contracts', under which PIPs are related to the benefits of additional patronage, with two benefit components: a user benefit (or consumer surplus linked payout) per passenger and an externality benefit per ex-car passenger payout for above-base patronage (i.e., patronage levels associated with minimum service levels).
(iv) 'Commercial fare' contract which is regulator-approved based on the average cost per passenger and is often linked to MSL obligations (e.g., Sydney private bus).
(v) Gross cost plus patronage and SIP contracts, which includes a fixed payment based on previous service levels before tendering and variations after, with service levels approved by regulator (e.g., Adelaide, Perth).

In addition, we note the payment model adopted for funding from central to regional governments under the New Zealand Patronage Funding scheme (Wallis, 2003). This essentially is of the 'gross cost plus economic-based patronage incentive' type, with the level of funding to each region depending on the numbers of peak and off-peak passengers carried (based on user benefit and externality benefit rates). This scheme, introduced some 3 years ago, has had considerable success in encouraging the development of services so as to increase patronage. Its success in this way has led to budgetary concerns and it is currently under review.

The payment rates associated with the form of contract establish the service delivery cost to government of achieving the strategic goals, which are usually expressed as dollar benefits to passengers and to other road users. Benefit rates can then be compared to the shadow prices of government funds. As discussed in the previous section, payment rates may be determined by two major processes: CT or negotiation.

There are a number of payment-related issues that require careful consideration. These are synthesised below:

1. The appropriate *level and structure of maximum financial incentive rates* has to be established, based on the economic benefits of attracting additional passengers. As noted earlier, these benefits comprise economies of scale ('Mohring effect') benefits from increased public transport services plus net benefits (environmental and safety) relating to mode switching, particularly from car use. The maximum warranted financial incentive rates are related to this benefit function, allowing for the shadow price of public funds. A number of studies have estimated incentive rates on this basis, including the New Zealand Patronage Funding scheme (Wallis & Gale, 2001).
2. Procedures are needed to *set actual payment rates to operators*, within the constraints of the above maximum levels but recognising that actual payments should be no greater than the amount required by an efficient operator to attract the additional patronage. One indicative approach to estimating the efficient incremental payment rate would be to base it on the operator costs of increasing service frequencies and the expected frequency elasticities, to derive the typical marginal cost per incremental passenger in a range of situations (peak, off-peak, etc.). These rates could be offered by government to the chosen operator. Alternatively, as part of the tendering process, operators could be asked to bid rates per incremental passenger (e.g., for up to 2% increase, 2–4% increase etc.); and these would then be compared with the maximum warranted payment rates.
3. Limited systematic evidence exists on the likely impacts of different payment rates on operator behaviour, and hence on their *effectiveness in generating additional patronage*: this would clearly be helpful in assessing how effective any rate proposals are likely to be in securing enhancements

in services and hence increases in patronage. The operator response will depend on its marginal cost function for different service enhancements in a range of circumstances (e.g., by time of day) and on the market response to such enhancements. The development of a better database of empirical evidence in this regard would clearly be helpful.

4. A growing number of PBCs are defined in a *multiple component form*, incorporating a baseline (or minimum) level of service financed by a fixed payment, and above-baseline levels of service and patronage (marginal activity) funded by various incentive payments schemes. While this two-tier approach provides some form of security to the operator (which is greater as the fixed payment becomes a higher expected percentage of funding sources), there might be a case for a single-tiered approach in which all service and patronage levels are funded by incentive payments. This is worth investigation since it might help to establish the merits of multiple-tiered approaches. The first tier of a two-tiered approach, often referred to as the MSL tier, raises many questions of definition and complexity. In a trusted partnership (T–O) under PBC, it is important to negotiate upfront a desired minimum service profile (coverage, frequency, fares, other service quality attributes – i.e., an agreed performance assessment regime) and an agreed commensurate fixed payment (either a fixed total sum as in Adelaide or a dollar per vehicle kilometre). How a suitable T–O negotiation process may be introduced ex ante in a CT context is unclear.[18]
5. A way of ensuring that T, O roles are defined through the outcome of a broad-based *systems planning and design* approach involving area agreements/quality partnerships is needed. Under the STO system, there is a tendency to focus on contracting at the operational level. However, there is much opportunity and perhaps high appeal in improving the tactical tasks (especially the interface between the T, O levels) through PBCs. Examples might include (i) putting the transport network design and implementation out to CT, especially where the interfaces between infrastructure and operations are critical to network integration; (ii) collecting all fares by smartcard, where collection is undertaken by a bank on behalf of government, as proposed for Chile.
6. *Service design and development* includes determination and development of the network, patronage, capacity/load factors, etc. It is unrealistic to expect operators (especially new operators) to present a service development plan at the tendering stage, for many reasons including a lack of sufficient market knowledge and appropriate expertise.[19] Service design and development may, therefore, be more productively determined by

either the regulator or by the consultants. An example of a service design and development initiative is to simplify the new operator transition period by introducing new operators to route-based contracts rather than area-based contracts. There are arguments in favour of service redesign at the tendering stage as well as during the contract term. In particular, the former promotes an opportunity for innovative input at a stage when it can influence the selection of the successful bidder, and in many ways provides greater clarity on what might be the best outcome in terms of cost commitment. The downside, however, is that some operators may promote service levels that are simply not sustainable, but which appeal to the assessment committee awarding the contract to operators who later find they cannot deliver. This is the winner's curse. Negotiating service design details with the winner tenderer establishes a stronger commitment to the outcome, since it must now definitely be delivered, and under the assumption that the contract will not be revoked, a great deal of careful commitment is likely to evolve. The implications of this for the procurement and payment process are also important. The ex-post negotiation simplifies the evaluation of the bids, and it might also increase the number of bidders. However, there is an unknown level of financial commitment ex post if the negotiations still have to be worked through, including the extent to which revisions of incentive payments may lead to budget escalation.

7. Negotiated contracts require *benchmark costs* [20] to be determined from diverse sources, including data, which may be available from the current group of operators and other local operators. Accumulated data from around the world may also be of use, although the considerable problems of transferability to a different operating environment need to be recognised (Some CT processes do publish full details of tender awards: for London see http://www.tfl.gov.uk/buses/cib_tender.shtml). The uncertainty associated with a benchmark cost analysis for a given area is best represented by a cost band. The location of the contract costs within the band would then be determined through negotiation. Benchmark bands are also required under CT to avoid the risk of contrived cost statements and possible appointment of an operator whose bid costs are clearly unsustainable. An 'open book' system to check costs is usually requested in negotiated contract processes, where it is less of a threat than under CT processes.
8. Existing T–O culture seeks the best value for money available within the means offered by existing government budgets. How can we grow *government budgets* where evidence points to growing value for money with

growing patronage and service? In Sydney, for example, the government has no more money to allocate (or redistribute) to bus services and is looking to secure greater value for money from the existing budget allocation (with allowance only for inflation adjustments). Despite public transport being promoted as an important agenda item for the current (labour) government, it is low priority relative to health, crime and infrastructure. Indeed the government is keen to reduce the subsidy budget to public transport, and is looking for ways to do this within a setting of a commitment to private operators (as well as the large government operator) who currently are fighting to survive financially with the contract-supported funding provided by government.[21]

4.5. OTHER ISSUES

Some specific issues associated with contracting that require consideration in most circumstances are presented below as a series of questions for ongoing deliberation.

An area of variable success is the commitment of the regulator to adequate *auditing and monitoring of operator performance*. This budgeted item often gets short change as the budgetary cycle evolves, resulting in a service drop-off unless there is a major complaint from passengers or politicians. A much more serious commitment to monitoring is required, especially where there are inadequate incentives to deliver services through the life of a contract. Internalising monitoring and reporting costs within a contract price has much merit. There should be a lesser need for monitoring when the payment system gives the operator incentives to provide attractive services. The costs of monitoring/auditing may be built-into baseline contract prices to ensure it happens. Such monitoring should provide a mechanism for developing KPIs on operating performance and service quality, giving all parties a rich data set for planning improvements in services. This approach should assist in ensuring that outcomes are checked against strategic objectives as well as contract compliance. It should also facilitate an open book approach to check benchmark costs (which may be more necessary and more acceptable under negotiated PBC than CT since it then implies a lower threat to the incumbent operator), and the regulator can source suitable evidence as widely as possible to establish confidence in revision of benchmark costs over time.

PBCs as presented have been used more extensively in the bus sector yet they have relevance for railways as well. A more considered assessment of rail PBCs is required to establish the portability of the bus experience to a sector that has a much greater investment in infrastructure under its responsibility (unlike roads that are treated as an investment not at risk). Klarmann (2003) illustrates the particular complexities of urban rail franchising where perhaps NC PBCs have most potential.

Flexibility in contract term can also assist in accommodating operator development. A range of options exists between contracts in Perth, Western Australia, with a life of up to 14 years including a renewal period, and the negotiated contracts in Toronto, which apply over 6 months; and the width of this range highlights the potential benefits of developing trusting T–O partnerships.

The introduction of *contract regimes* for the provision of bus services is usually premised on a prior assumption that the size of the physical contract area is given and that any policies related to interactions between contract areas such as integrated ticketing and fares require agreement. Research is required to establish a position on appropriate contract area sizes before re-contracting, and on the benefits of service quality-related issues like an integrated fares policy, that are assumed to be impacted on by the number of contract areas. Given that a growing number of analysts (especially in Europe and Australia) are promoting the appeal of increasing physical contract area size to facilitate service quality-related issues like an integrated fare regime, it is timely to set out the pros and cons for such changes to ensure they are not counter-productive to the desired outcomes of a reform process. Alternative ways of delivering cross-regional and broad-based network benefits should be considered at the same time, to assess whether the perceived gains from a reduction in the number of contract areas is real or illusory (see, e.g., Cmabini & Filippini, 2003). If the gains in network effectiveness and efficiency are not sufficiently large to outweigh possible losses in internal efficiency, then the case for amalgamating contract areas is weak. Where the major focus is on local service provision, opportunities to deliver appropriate cross-regional and cross-network services might best be revealed and promoted by T–O partnerships.

Regulatory capture is always raised when discussing partnerships across the STO supply chain and this is often used as an argument (maybe 'excuse') to throw water on the proposition that trusting partnerships can achieve a great deal in securing appropriate system-wide outcomes (in contrast to the more narrow focus on securing the least cost operator for a service that lacks innovation and network integrity benefits). At another level, the same argument is used to claim that CT leads to market concentration, although all systems incorporating T–O interaction are subjected to this claim. We need more evidence on the extent to which regulatory capture is a serious issue and the extent to which it may be the product of information asymmetry in favour of a specific operator. In particular this investigation should be conducted with the objective of establishing how to make contracting work at the T and O level. Project alliancing, sharing risk and reward, and replacing the master–servant relationship with a trusting partnership, should all be central issues. The challenge then would be to bring the regulatory component of STO to a commitment in favour of genuine partnerships that are free of corruption where may be present.

Regulatory challenges differ depending on whether there exists a well-defined and stable regulatory environment or a poorly defined and unstable (corrupt) environment. Both environments make CT and negotiated PBCs problematic; although operator associations appear to have a growing role in assisting government in preparing operators for the new PBC environment, be it via CT or negotiation. This is especially important for situations where there are many small operators, many of which lack experience in dealing with formal supply mechanisms (as seen in South Africa with the empowerment of operators using 16 people capacity vehicles). The city of Recife on the northeastern coast of Brazil offers a detailed example (in Appendix 4B) of the challenge facing many developing economies.

4.6. CONCLUSIONS AND RECOMMENDATIONS FOR ONGOING INQUIRY

There are a number of very clear messages from this assessment. The key ones are:

1. That any system of PBCs should be linked to an outcome-based integrated system in which all players throughout the STO framework participate as trusting partners.
2. Little research has been documented on regulatory failure. Too much focus is often placed (at least by the regulator) on the performance of the operator whereas the success or otherwise of the contractual regime is also equally dependent on the performance of the regulator.
3. The enthusiasm with which many developing economies are embracing regulation to reign in or eliminate the high level of service (even if chaotic) provided by the informal or alternative transport sector (be it legal or otherwise) should be carefully thought through in order to preserve the substantial benefits to passengers of very flexible public transport systems.

4. Moves to consolidate down to a few large operators can learn from the experiences in developed economies (e.g., the Melbourne and British experiences with a few very powerful multinational players who have a tendency to offer very attractive short run prices that are not sustainable in the longer run over the duration of the contract and who subsequently put pressure on the regulator to revise the financial support upwards). This is particularly a problem with rail-based contracts, where there are few players in the market. However, if negotiated contracts are thought of as a stage that follows competitive tendering, formalisation of the CT–NC sequence may be unavoidable in a developing economy setting.
5. Competitive tendering and NC should be seen as a suite of PBC and used as instruments of change and service delivery where appropriate. We have detailed the settings in which each has special attraction.
6. Importantly CT-linked and non-CT linked PBCs have strong complementary roles in a dynamic service delivery setting where (i) some markets are still evolving and maturing (including the regulatory framework) such as in South Africa, (ii) some have evolved and are inefficient and even corrupt at both the T and O levels, such as in Brazil, (iii) some have been successful under a CT treatment (others have not), (iv) some seem ready for a progression from an initial CT setting to an NC setting, and (v) some seem ready for an immediate NC treatment without a prior CT stage.
7. The encouragement of co-operatives to co-ordinate the activities of individual operators in the alternative transport sectors (as in Brazil and South Africa) has to be treated carefully. We need to avoid the risk that such co-operatives are managed in a way that increases the debt to operators through improved access to finance and that the beneficiaries are not passengers but the managers (i.e., 'regulators') of the co-operatives. We must recognise and preserve the benefits of the informal van sector – lean and light on institutions, cost-efficient, high service quality, strong customer focus and more flexible to match demand and supply.
8. Comparative assessment of the various contract models, especially empirical evidence needs to be better documented, especially determination of the dynamics of contract type mixtures.
9. In developing guidelines for PBCs in practice, a greater focus should be placed on (i) the definition of MSLs, (ii) establishing detailed measures for benchmarking best practice (in terms of cost, patronage and capacity delivery), (iii) determining critical KPIs (for operating performance and service quality indicators, (iv) setting up a scheme for monitoring/auditing and maybe internalising this cost in contract price

and (v) establishing appropriate incremental patronage payment rates based on the lesser of economic benefit/shadow price and the minimum cost of providing service to accommodate additional patronage.

10. PBCs must be assessed in the context of social equity objectives that are backed by KPIs (especially for gross cost contracts) of operator performance (e.g., on-time running) and user-based service quality indicators (e.g., cleanliness of vehicles, friendliness and helpfulness of driver).

APPENDIX 4A. THE CHILEAN PROPOSAL[22]

Santiago Chile is currently (i.e., 2003) finalising a new integrated public transport plan in which competitive tendering of operations of buses is central to the plan. The existing 8,000 buses provided by 4,000 operators (mainly independent owner drivers of a single vehicle with some larger operators) will be replaced in 2005 (after a June 2004 CT process) with 10 operators providing feeder services and 5 operators providing structural or corridor services.[23] The latter will be a mix of articulated and bi-articulated buses on mixed traffic and dedicated infrastructure as appropriate, in 5 areas each with on average 10 corridors routes, with a total of 51 corridors throughout the system. The new approach has been described by SECTRA (Secutaria Ejecutiva Comision de Transporte), the planning agency, as revolutionary. The planning of the entire system of public transport is 'based on conceptual, scientific and theoretical application' using an investment of over $1 million dollars to develop a comprehensive modelling system. Contract length is still under discussion but 10–14 years is the current view for corridor contracts and 3–10 years for feeder route contracts. However, limited thought has been given as to whether this is appropriate or whether a negotiated PBC may be the way ahead after the first round of CT has bedded down a set of 15 experienced quality operators.[24]

Feeder Services

The plan is to tender the feeder services using a system SECTRA describes as a patronage incentive scheme. Operators may be required to bid on at least 5 area contracts to be eligible to win one or more contracts. The bid price will be a total price related to a price per passenger[25] for a pre-defined service design and level. This price will be received by an operator and the fare will be collected by a tendered money operator (most likely a bank). The fare will vary by the type of trip (i.e., only feeder, only corridor and a combination) and is determined by the regulatory agency Trans Santiago based on current fares (about 300 pesos or $US0.45) and nature of patronage to be serviced. Thus, the fare is a given for the operator. Importantly, the planning agency has a good idea of patronage levels (based on existing operating experience) and uses this to establish how much money will be raised by the actual fare charged in each feeder area. This money will have to pay for the operator contracts in feeder areas and maybe also to support corridor services if some funds are available. If the fare is greater than the price/passenger received by an operator then the 'surplus' revenue will be available to cross-subsidise operators who receive a price per passenger payment, which is greater than the fare.[26] SECTRA have assumed that the method of cross-subsidy between contracts will approximately balance out so that there is no additional subsidy to operators. They recognise that this may not occur and have allowed for some subsidy support under a contingency fund. The actual patronage is determined in advance of the tender and is crucial to the operator's calculation of the bid price. The bidders will have full access to the patronage and forecasting models developed by SECTRA.[27]

Corridor Services

For the corridor routes, a service payment (in $/vehicle kilometre (vkm)) is proposed in which an operator offers to deliver the pre-defined service for a cost per vkm entitling the lowest cost bidder the right to operate with cost per service kilometre support from government. The structural route operator also does not get any of the fare. Under the service contract the regulatory agency proposes that vkm can vary within a range plus or minus 20% so that the operator has some incentive to grow patronage via growing service kilometres up to 20% of the approved level, but importantly this remains the decision matter for the authority. Although operator may be permitted to drop as low as 20% of agreed vkm's without any penalty of non-compliance (in recognition of what may be reality from time to time when the economy deteriorates, etc.), this is a decision made only by the regulator. The cost per kilometre is assessed against knowledge of the range in which best practice is likely to occur, which is currently heavily influenced by the performance of incumbent large operators.

Finally, the regulatory agency (or bus controller who will also be tendered), will have responsibility for monitoring the performance of corridor operators, although this is only a proposal at this stage.[28] Central to this responsibility is a customer satisfaction survey. All corridor operators will be surveyed and ranked in respect of customer satisfaction. Operators will be eligible for a bonus (although it is not clear how this is determined – we were advised that the methodology has now been established but not the actual dollar amounts or the threshold criteria). Operators underperforming (however, measured) will receive financial penalties, which will be used to reward operators who have performed well with a financial bonus.

The system is interesting but further clarification is required. It appears that we have a tendered PBC regime in which an MSL is imposed from the integrated metropolitan plan (developed by SECTRA), which is not linked to an agreed CSO payment (as in the H–H model) but which is then tendered under two regimes: (i) the feeder services which involve the offer of a price per passenger (but all fares are collected by a tendered money collector using smartcards) and (ii) the structural services which involve an offer to win the right to operate the MSL for a cost per service kilometre with all fares being returned to the money collector. A financial bonus or penalty derived from a customer satisfaction survey (also known in Australia as a performance-assessment regime) is linked to the corridor services only. Corridor operators can benefit from patronage growth in feeder markets, which is encouraged by the patronage incentive payment since many of these bus users will move onto the corridor services.

APPENDIX 4B. THE INFORMAL OR ALTERNATIVE TRANSPORT SECTOR: RELEVANT OR REDUNDANT?

The city of Recife on the northeastern coast of Brazil has population of 1.4 million. A mix of public transport operators and systems co-exist: railways, buses and vans (the latter are called the 'alternative transit system'). Trips made by public transport are 46% (38% by buses, 2% by railways, 4% by the 'alternative' system, 2% by contracted transport); and 31% use motorised individual transport (27% for private car, 4% for taxi and hired cars); pedestrians come for 23%. The bus system plays a major role in the urban journeys, with services provided by 20 private operators with 2,376 vehicles. The average age of the fleet is 4 years; per day, the fleet runs 22,325 trips and 645,266 km and carries 1.2 million passengers. This system has been increasingly being challenged by informal ('alternative') operators that use smaller vehicles to operate a chaotic network, uncontrolled by the authorities (Prefeitura da Cidade do Recife Companhia de Trânsito e Transporte Urbano, 2001).

A recent inquiry in 2000s revealed the presence of 3,683 vehicles, which are active within an area that corresponds to 60% of the whole region. Beyond these figures, the total sum of irregular vehicles is supposed to amount to 6,000 vehicles for the whole region. The counted vehicles alone would carry around 163,000 passengers per day (thus more than the railway system, which is responsible for 120,000 passengers per day); extending these results to the remaining not scrutinised area (40%) suggests 272,000 passengers being carried by the informal system, which corresponds to approximately 19.4% of the total demand served by the official bus system controlled by the EMTU (1993)/Recife (*ibid*). This illegal competition and the competition by individual transport as well the economic crisis have provoked a reduction of the patronage in the official transit system. Whereas in 1990 the average number of passengers carried by a bus in a day was around 1,000, in 2001, this same figure has dropped to 514, which means a reduction of 50%. This reduction has led to an accumulated deficit of the official bus system (EMTU controlled system), which amounts today to millions of reais (ca. US$40 millions). This is a key ingredient in government interest in using competitive tendering to 'tidy up' the market of suppliers.

CHAPTER 5

CONTRACT AREAS AND SERVICE QUALITY ISSUES IN PUBLIC TRANSIT PROVISION: SOME THOUGHTS ON THE EUROPEAN AND AUSTRALIAN CONTEXT

5.1. INTRODUCTION

The reform of the bus sector in many countries has focused on alternative service delivery regimes such as competitive tendering[29] and performance-based quality contracts (see, e.g., Chapter 8 and Preston & van de Velde, 2002 for details). Two issues that arise when detailing specific reform strategies are the geographical definition of the service area (or even whether it is a single route as in London) and the flow-through implications of service quality initiatives such as integrated fares.[30] The latter relates to the ability of a passenger to travel between public transport modes and operators on a single fare as well as potentially offering time savings.[31]

In developing an implementation plan for performance-based contracts (PBCs) (such as the one developed by Hensher and Houghton (Chapter 7), a number of commentators have raised the question of how many contracts should best be provided within a particular geographical setting. Should we take the existing contracts (and areas) or rationalise the contracts to a smaller number? The arguments proposed for fewer contract areas are in the main related to administrative coherence and passenger benefits from network integration. A concern with fewer contracts (depending on the meaning of 'fewer') is the potential loss of internal efficiency and the high risk of monopoly power and/or market dominance, with resultant pressures on government to increase subsidies beyond what currently exist and/or are in any sense optimal.

In this chapter we review the arguments for and against a range of reform initiatives associated with the determination of the geographical size of contract areas, as well as revenue allocation and patronage benefit issues linked to integrated fares associated with cross-contract service delivery. Although we focus on Australia (Sydney in particular), and to a lesser extent Europe, to illustrate some of the evidence, the arguments presented are of relevance universally and are especially useful for the USA, which appears to lag behind the reform programmes of Europe and Australasia.[32]

5.2. CONTRACT AREA SIZE AND NUMBER

> The problem is that individual firms in the transportation industries provide service only over limited portions of a network, but [some] customers' demands extend over the entire network. The necessity of providing through … service from any origin to any destination requires cooperation among firms who are also expected to compete in the new environment of regulatory reform. These industries have been regulated in the past precisely to deal with the 'interconnect' and 'competitive access' issues. But the [competition policy] laws generally presume that firms should compete [in a potential if no actual sense], not cooperate (Tye, 1987, p. xviii)

Is there such a thing as an optimal contract area size in a geographical sense?[33] What criteria might one apply to decide on this? Presumably, the answer relates to demand-side considerations such as network connectivity impacts (economies of scope through networks, integrated fares, etc.) and the supply side in terms of cost and service delivery efficiencies. It is not dissimilar to the arguments on the optimal number of firms in an industry.[34]

There are two issues (at least) to address – what likely changes in network service delivery are desired and can be achieved by amalgamating contract areas, that cannot be achieved by alternative strategies such as establishing network alliances (even incentive-based ones[35]) within the existing contract area regime; and will such amalgamations lose the internal (to an operator) efficiencies that currently exist and which promote sufficient observations for benchmarking performance? How many contract areas are appropriate? Preston and van de Velde (2002) comment that the U-shaped subsidy profile detected over time in competitive tendering (CT) is in part due to the winner's curse,[36] but more importantly in the current context, in part due to excessive concentration or collusion. The upping of prices in re-bids is becoming common (as observed in Europe in particular) as the number of bidders drops (as a result of fewer operators in the market). Contract area size is a feature of the literature on spatial monopoly where each contract area may be in the hands of a few operators who are able to collude activities across contract areas under their control. By amalgamating contract areas, this is tantamount to the same implications for efficiency (albeit legally) as collusion.

The trade-offs between network/demand economies and internal efficiency will depend on a number of structural and historically contingent characteristics including such different aspects as urban development and operator culture (Carlquist, 2002). This was certainly true in the Sydney context in the early 1990s when the New South Wales (NSW) 1990 Passenger Transport Act was introduced. It defined a suite of 78 contract areas based primarily on incumbency (tantamount to grandfather's rights). Since then the number of operators has been reduced (while the contract areas have remained in tact). New global operators have moved into Sydney (e.g., National Express from the UK, Connex and Transdev from France) looking for opportunities to expand in the Australian market. Where geographically adjacent operators have been willing to sell, in part due to pressures to sell from the large global operators, but also because of the perceived uncertainty of the new reform agenda, we have evidence of larger service areas under one operator (strictly the same contract areas as before but now bringing a capability of cross-contract operations).

The State Transit Authority of New South Wales (STA), the government-owned operator, is the largest operator with 26 contracts and operates the public bus network which covers the almost half of Sydney (1.6–1.8 million population, nearly 800 km^2 and 1,750 buses operating out of 11 depots) centred on the Sydney Central Business District (see Fig. 5.1). It has a lot of adjacent contract areas so that their services are not delivered on a contract area basis per se, operating as one very large provider. The STA has designed a route network of services that takes passengers to key centres across a region, not just within the contract area. This network economy is achieved, however, at a relatively high internal inefficiency cost of $4.86 per bus kilometre[37] (in contrast to the best practice cost of $2.60 per bus kilometre for private operators who currently have 53 contracts among 30 operators). The important question herein is the extent to which the cross-contract area service provision has contributed to these higher unit costs or whether it is the product of government ownership and specific restrictions of service delivery. Part can be attributed to externalities such as traffic congestion; based on the STA's operations outside of the Sydney Metropolitan Area (in Newcastle, a Regional Centre 120 km from Sydney with a

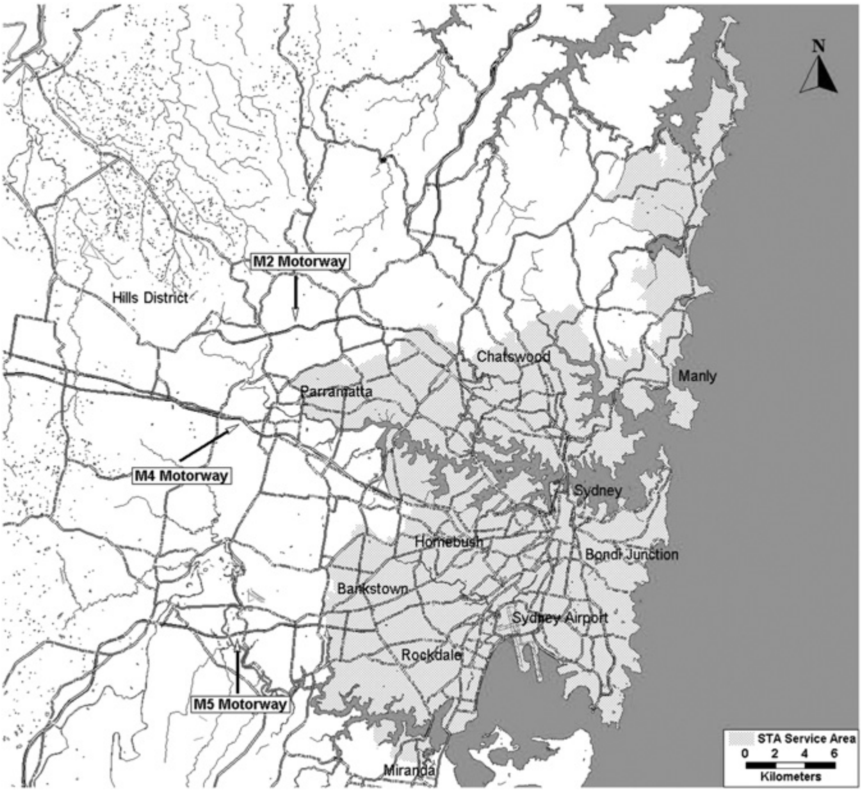


Fig. 5.1. The Sydney Metropolitan Area and STA Contract Area.

population of about 500,000), we could reduce the \$4.86 to \$3.54 (Daniels, 2002). However, internal inefficiency must account for much of the remaining increment above \$2.60.

The literature on industrial organisation from which ideas central to tendering evolved such as principal–agent relationships, transactions costs and economies of scale and scope, puts forward compelling arguments that many of the gains in service delivery to the market can be effected through preservation of smaller effective management units working within a range of alliance structures, where each alliance is established to best accommodate the interests of the market (i.e., customers) and the interests of the supplying stakeholders (see Hay & Vickers, 1987; Williamson, 1987). To assume that one large organisation with a single large contract area (or even a few under an oligopoly) is the best way forward in servicing the market is questionable. It assumes that the transactions costs between operators and customers are excessive and the transactions costs within an organisation are non-existent or minimal.[38] Indeed the literature on the economic theory of regulation (or 'capture' theory) describes how regulatory agencies may end up more or less in the pocket of those whom they purport to regulate. The response in some industries has been the dismantling of such regulatory frameworks through economic deregulation (e.g., airlines and telecommunications) with a replaced regulatory regime focused on monitoring.

There is an analogous literature arguing for local specialisation and alliances instead of the formation of large single-entity businesses. Indeed it does not take long before we see many of the very large entities essentially operating as a set of separate entities with occasional cross-subsidy to facilitate short-run (at least) viability across the entire set of organisations under one control. This breeds inefficiency (like governments bailing out their own public monopolies) and upward pressures on subsidy support from government. As Preston and van de Velde (2002) state "…governments caving in to operators suffering from the winner's curse or generally finding life tough was a real threat to competitive tendering in some countries and situations".

Fundamentally, the reduction in the number of contract areas runs the risk of further promoting dominance and a further move away from the ideals of competition policy.[39] It is a dangerous move if it erodes the competitive base of the bus market in the sense that it reduces the ability to promote and maintain a process of effective or potential competition so as to achieve a more efficient allocation of resources.[40] In large measure then we have to put to test the case that such amalgamations deliver additional benefits that more than outweigh the additional costs.

However, alliances do not just happen. The market may well send signals to encourage such alliances but there is no guarantee that the signals will be registered and acted upon. To ensure market signal-activation, appropriate information and incentives need to be put in place. Government through its regulatory agency can make a major contribution to this process. In the presence of imperfect information, signalling and incentive systems are at the centre stage. To date, in most international settings where regulatory reform is active, we have little evidence of alliances (although see Norway in the next paragraph), which is disappointing, but this may well be explained by the strategic intent of the new (global) players and the lack of incentives in the past. The evolution of alliances will require much more incentive-driven initiatives by the regulator especially where we see a loss of internal efficiency due to the scale of operations. There is no denying that this happens, but what is important is the size of an operator beyond which such internal efficiencies come into play. In Sydney, for example, where most recent purchases involve operators controlling more than 100 buses, these are worrying signals (see evidence below).

There is an interesting history of co-operation and merger in Bergen, Norway (Carlquist, 2002). Although a merger attempt between the two major operators failed in the early 1990s, it led to substantial route and fare co-operation. In 1998, a new merger attempt succeeded. Furthermore, all bus companies in the region already co-operated in an alliance regarding electronic ticketing fare coordination and purchasing. It was therefore easy for the regional public transport authority to impose a requirement for integrated fares in the performance contract, initiated in 2000. The operators were obliged to have a common ticketing system and fare tariff, but there is no limit to the upper fare level. There is no evidence to support (or falsify) the existence of new patronage attraction or increased benefits to existing passengers, although Carlquist (2002) suggests that the latter is more likely than the former. In either case, it would be difficult to hypothesise that a 'successful' integration was due to regulatory intervention, as a successful alliance between the operators already existed.

Whether by amalgamation of ownership or alliance formation, these are both merger phenomenon. For example, combining three contract areas into one area is a (horizontal) merger and should be assessed along the same lines as the merger of two organisations. If there are economies of scale (for the exact same service type) then there are efficiency gains. The realisation of these gains however could be offset by welfare losses due to reduced competition, be it actual or yardstick, in the case of either CT or PBCs (the latter during the contract period in competing for incentive payments, the former at the time of bidding). DeBorger and Kerstens (2000) review the evidence and conclude overall that there are no economies of scale but mild economies of scope associated with demand complementarities where the evidence suggests that spatial demand exists beyond contract/operator areas. The latter is an empirical issue. It is investigated below for Sydney, where we see very little inter-contract area use of public transport but opportunities for cross-regional services capable of being delivered efficiently by a single operator. Indeed as organisations increase in size, they lose the relative precision required to establish the value of specific activities – in contrast, through alliances there is much more precision and transparency. A synthesis of some key themes is given in Table 5.1.

Table 5.1. Synthesis of Key Issues in Determining Optimal Size of Operator/Contract Area.

Theme	Comments
Density of route network and network economies	• As it increases there is operational dependency on availability of fixed facilities (central depot, local terminal…) • Very high fixed costs of depots which require sharing of these costs • Presence of such high costs involves a trade between sharing costs over many more activities/services, risks of diseconomies of scale and elimination of potential competition (either leading to entry under deregulation or competitive tendering or competition for incentive payments under PBC)
Route structure	• The balance between degrees of hubbing ranging from hub-dominated to more uniform distribution in urban area moves to latter as a continuous spatial diffusion of urban activities takes place
Demand complements	• Attributes of individual services as demand complements means that a change in frequency (say) of one service affects the demand for another
Internal efficiency	• Delivering services under benchmarked best practice in respect of cost efficiency, cost effectiveness and service effectiveness

5.2.1. The Theoretical Argument

The relevant literature on the optimum number of firms in a market focuses on the cost and performance structure of each firm, both in respect of the supply of services and the welfare benefits to passengers of a specific supply regime. Evidence of scale and scope (especially network economies) is an important basis for commenting on the appropriate number of operators (and hence contracts).

Transaction cost economics (TCE) provides an appealing framework within which to develop the arguments for the roles of the market and governance. A transaction occurs when one stage of activity finishes and another begins. With a well-working interface these transfers occur smoothly. Establishing a smooth transfer is what network economies (including integrated fares) are all about. Their achievement is possible through a number of strategies such as alliance contracts and merger (see the Bergen experience cited above). TCE supplants the usual pre-occupation with technology and distribution costs, with an examination of the comparative costs of planning, adapting and monitoring task completion under alternative governance structures. It is as much about transactions within a single entity (e.g., one bus operator, a regulator) as it is between entities. It pays special attention to information signalling and processing (and its asymmetry throughout the system), bounded rationality (i.e., the ability to process a limited amount of information), hazard, opportunism and asset specificity.

Transaction cost economics maintains that it is *impossible* to concentrate all of the relevant bargaining action at the ex ante contracting stage (which is what CT essentially does). Instead, bargaining is pervasive in which case the institutions of private ordering and the study of contracting in its entirety take on critical economic significance. Performance-based contracts align with this view (see Chapter 8) since the market operates actively throughout the contract period (under signals delivered through incentive payments). The behavioural attributes of human agents, whereby conditions of bounded rationality and opportunism are joined, and the complex attributes of transaction with special reference to the condition of asset specificity, are responsible for this condition (Williamson, 1987, p. 178). Alignment of incentives is central to efficient contracts and property rights. The latter emphasises that ownership matters, with rights of ownership of an asset defined as the rights to use the asset, the right to appropriate returns from the asset, and the right to change the form and/or substance of an asset.

Transaction cost economics acknowledges merit in both monopoly and efficient risk-bearing approaches to contract. It insists, however, that efficiency purposes are sometimes served by restraints on trade. (Williamson, 1987, p. 188). This statement by a pioneer of transactional economics, X-efficiency and contracting theory, is crucial to the discussion because it puts forth the argument that examination of the underlying attributes of transactions discloses that restraints on trade can help to safeguard the integrity of transactions when firm-specific investments are at hazard.

5.2.2. *The Evidence on Cost Savings from Scale of Operations*

One useful analysis to establish the potential gains for larger operations (which also means larger contract areas and hence less operators) is to look at the evidence on performance outcomes when tendering for different size bids. A caveat – the great majority of the empirical evidence focuses on operational cost savings and little about the true costs of conducting tendering and monitoring etc. What we see is that the CT of *a large public sector provider* delivers an immediate cost saving *but it is a once-only gain.*[41]

This gain is greater when the pre-tendered unit is large (as in most government-owned bus operations, such as occurred in London in the 1980s and 1990s) and it is being tendered out as a set of smaller contracts. Subsequent re-tendering of the smaller contracts however leads to very little cost savings if any. Indeed the often-quoted cost savings up to 20% (net of administrative costs of tendering) do not shed light on the crucial question as to what proportion of these savings can be attributed to competitive tendering per se.[42] The switch to a smaller operator with lower fixed costs and overheads in itself, could achieve these savings regardless of the mechanism used to select the operator.

The main message hence is that savings increase as system size increases, which implies that if we move to larger contracts by operator merger (or buy outs by large players) we can expect increases in the costs of doing business. While this might not be disputed, the rebuttal is likely to come in terms of network economies on the demand side. This is where we draw on transaction cost economics to assist, since even in the presence of economies of network integrity there are alternative ways of delivering optimal network performance without creating a small number of large and relatively inefficient contract areas.

5.2.3. Summary of the Main Argument

In determining the appropriate size of contract areas it is important to recognise both internal efficiency and external benefit arguments. Internal efficiency arguments recognise the importance of the performance of the service delivery entity regardless of whether the objective is commercial or social obligation. Efficiency encompasses cost efficiency, cost effectiveness and service effectiveness. External benefit focuses primarily on accessibility and in particular the integrity of the network and associated network economies.

In considering the appropriate size of the service delivery unit (SDU), the costs of transaction are very important. These costs are not limited to the inter-firm environment (which would include integrated fares and servicing of an inter-connected network) but include the costs outlaid within a firm. An issue of relevance in achieving the efficiency and network benefits is the revealing of information through appropriate signals (either from the market or by the regulator) to ensure that the best information is acted upon in order to deliver services to the market at cost-efficient and effective levels that, within a subsidy-dependent environment, delivers best value for money (in an efficiency and equity sense) for the scarce subsidy dollar.

Looking at the internal efficiency of an SDU, the evidence from the published literature supports the view that there are no scale economies (over 100 buses)[43] but mild network economies.[44] The latter translates in particular into an argument for having fewer (or even one) SDU operating a network-based cross-regional service, since the argued benefits to passengers are greater than if the cross-regional services were provided by more than one operator. The assumption implicit in this evidence is that passengers would have to transfer between modes (or bus operators) to complete their journey. These network economies are relatively weak where cross-regional services are shown to be deliverable by smaller operators who move through other contract areas or where, through contract area alliances for specific routes, they can pick up and drop off passengers anywhere along the route.

A good example in Sydney of the former is the private operator, Forest Coaches, who has a service from St Ives/Chatswood (20 km north of the city in a very wealthy area) to the city; a good example of the latter is the 35 km orbital service about 5 km out from the CBD in Perth (Western Australia) operated through an alliance of three operators. This last example is equivalent to what Adelaide (South Australia) would refer to as a route-specific contract across contract areas – see Appendix 5B. Creating a monopoly supplier to deliver the mild network economies is false economy since it will almost definitely lead to major losses in internal efficiency. Rather, given the evidence from the Transport Data Centre (TDC) of the NSW government that the majority of travel in Sydney occurs locally[45] (mainly within one contract area but also between two adjacent contract areas), typically over 80% of all trips (often within a single contract area using a bus service locally or to access a rail interchange), the risk of delivering highly expensive local services to the majority of users just to satisfy a claim on network economies for a small amount of patronage service delivery is poor economics. Indeed, encouraging longer trips by any form of transport seems inconsistent with a desire to curtail travel and promote more local activity.

An important message from the institutional economics literature is that we should focus on efficiency and not market power (the concern with reducing the number of contract areas); and hence we should not aggregate operators or contract areas just to gain network benefits in situations where most of these benefits are within an existing contract area in the main. Through recognition of market opportunities (using appropriate signalling methods to reveal and share information and hence reduce information asymmetry) created by partnerships between all operators and government (via the regulator), and the formation of operator alliances to serve specialised cross-regional market niches, the major transaction costs (e.g., information asymmetry) appear to be more than offset by the huge gains in internal efficiency associated with operators with contracts in the 30–100 fleet size range. Importantly, an individual operator may have more than one contract (indeed many do), but there are sensible arguments to support the maintenance of each contract as a separate business centre. Large operations such as many Asian-based bus businesses (e.g., in Hong Kong) might benefit by reviewing their structures and indeed may reduce the growing levels of subsidy support that in part funds inefficiencies.

5.3. INTEGRATED FARES: REGULATORY CONTROL AND/OR GENUINE BENEFIT TO PASSENGERS?

> Do people need to use more than one mode of public transport/operator to use public transport as an alternative to the car? Maybe the transfers associated with multi-modal movement are a major barrier regardless of what fare arrangements are in place.

Integrated fares are claimed to be a way of attracting more public transport patronage because they enable one to purchase a multi-modal and/or multi-operator ticket at one point in time from one source. Although there is initial appeal in this fare strategy, the justification must be based on an agreed set of objectives. The most important must be a benefit to passengers (and associated flow-through to operators and the community at large). It is assumed that one of the reasons why public transport is not used as much as it might is the poor integration of services across the network. One feature of poor integration is the need to purchase a separate ticket from each operator, which is assumed to be more expensive than the purchase of a single multi-modal/operator fare because of the fixed cost component in each ticket. The presumption is that there would be a single fixed component in an integrated fare (although this needs to be demonstrated).

Over-riding the actual fare level is the issue of network integrity and what this actually means for passenger growth and benefit. What is the evidence that passengers do actually want to travel by a number of public transport modes across a network if the modes were better integrated? What is the evidence that integrated fares is the solution (or even a significant contributor)? *The counterfactuals would have to show that improved integration, on whatever criteria are adopted, would indeed show movements between modes* *and operators that are currently not able to be undertaken*. Indeed the opportunity for such travel does exist in most cities (at least to some extent) in terms of services available, but is it what people want? Such a system leads to transfers and with greater dominance of a few operators there is a real risk on hubbing whereby transfers become a negative feature. The evidence in Appendix 5A from around the world initially looks compelling, but it must be interpreted very carefully. What exactly are we seeing – some sort of discount disguised through integrated fares and/or genuine contributions to improving mobility across the network?

To illustrate this matter, Table 5.2 shows the year 2000 evidence on public transport use in Sydney involving more than one public mode. The use of multiple public modes in 2000 is 17.4%. This table distinguishes the number of times in a trip that a specific mode is used. Of particular interest is the use of more than one bus for a one-way trip. Out of a total of 1.29 million daily passenger trips that involve at least one public mode in a trip chain, 2.861% of all trips (i.e., 36, 982 trips) involve two or more buses. Indeed it might be argued that switching between buses highlights a downside of services that is better delivered through single-vehicle cross-regional services. The greater amount of the multiple-bus trips are on government buses (31, 508 or 85.2%) operating close to the CBD, which may say something positive about the ability to travel beyond contract areas by bus, although it says something negative in respect of the requirement to have to transfer.[46]

Inter-connectivity involving more than one bus operator in Sydney is negligible (even if one argues that this is due to relatively poor existing inter-connectivity) and is unlikely to be of concern to most of the travelling population. While it might be argued that the nature of the existing network of services denies this opportunity (and certainly the counterfactuals are not available), if such network connectivity were to be provided and would increase patronage, the issue of relevance here is whether cross-regional and long-haul metropolitan services can be achieved under existing area contracts by appropriate alliances which preserve the efficiencies of each operator (including transaction cost advantages).

The recent growth in cross-regional services in Sydney by private operators without transfers demonstrates one useful counter-factual in which a passenger can travel on a single mode/single operator service without transfers over long distances within the Sydney Metropolitan area (to/from the CBD which is not owned by a single contract and hence an open access service zone). Examples include the Westbus M2 and Hills services (in the northwest), the Harris Park Citybus (from Parramatta in the west) and Forest Coaches St Ives/Chatswood-City service (in the north), all of which

Table 5.2. Average Day Linked Trips Involving At least One Public Transport Mode, HTS2000.

			Public Bus					
Ferry	Private Bus	Train	0	1	2	3	4	Total
0	0	0		338,364	28,065	1,396	346	368,171
0	0	1	446,502	72,852	3,229			522,583
0	0	2	34,132	2,868		197	235	37,432
0	0	3	2,739	571	214			3,524
0	0	4		428				428
0	1	0	267,790	2,372				270,162
0	1	1	45,883	2,605				48,488
0	1	2	1,926	365				2,291
0	2	0	6,688					6,688
0	2	1	2,471	132				2,603
0	3	0	1,397					1,397
1	0	0	15,281	5,166	1,070			21,517
1	0	1	2,574	1,044				3,618
1	0	2	1,252					1,252
1	1	0	634	234				868
1	1	1	375					375
2	0	0	1,055	159				1,214

Note: Data include trips which may have used other (non-PT modes). The other modes are ignored, therefore 1 public bus may mean 1 public bus only or 1 public bus plus car.
Source: Transport Data Centre Household Travel Survey 2000, Transport NSW.

serve the outer suburbs and deliver passengers into the CBD (see Fig. 5.1).[47] Similar examples exist for the STA except that many of the STA services are across contract areas belonging to the STA enabling pick up and drop off across the contract areas (although one might argue that strictly this is violating the terms of a contract). The need for integrated fares in these examples (where public transport is showing evidence of serious competition with the car) is not relevant.[48]

Integrated fares are a form of regulatory intervention if imposed on all operators from above since all must conform to the grand plan. As Hibbs

(2000) has indicated, constructs of integration (of which integrated fares are an example) lead to a weakening of both effectiveness and efficiency. It denies individual operators or groups of operators the full ability to be responsive to market opportunities in ways that are consistent with delivering the appropriate services to customers. Again, Hibbs among others argues that other than the regard for safety and issues of scale and power, public passenger transport is a market-based, customer-driven activity and especially with regard to its relationship with the private car, from where most of its competition comes. Indeed integrated fares dictated across the board may well be inequitable as well as an inefficient way of securing optimum social benefit.[49] What we need is market-based fares policies that are designed to benefit users, and the best test of this is the levels of patronage resulting from the policy. If a specific arrangement or alliance between operators in a particular public transport chain sees merit in integrated fares then this should be supported, but not as a carte blanche no-choice policy. The 'one-size fits all' philosophy is very dangerous and counter-productive.

5.3.1. What is the Broader Evidence on Patronage Benefits?

The matter of integrated fares and impacts on patronage is not well studied. There are virtually no published papers on the topic that make the link clear and unambiguous. That is, unless one can separate out all the other changes that are happening at the same time (e.g., fare discounting),[50] it is not possible to make any sensible statements on the specific contribution of integrated/inter-modal/inter-operator fares.

In reviewing the literature, we have found a number of comments that state that inter-modal fares are often inappropriate where one has mainly mode-specific travel. That is, most circumstances where the topic is mentioned, talk about limited modal switching (i.e., rail to bus) and focus on single-mode discounted fares and other deals (including the growing interest in multi-purpose fare media that enable one to use a smartcard on buses, shopping, cinemas). The examples never refer to smartcards for travelling on buses and trains, which is interesting by its absence.

The studies in Appendix 5A are based on a literature review by Booz Allan Hamilton (BAH) in 2002. Most are questionable and indeed one of the better studies by London Transport (Fairhurst, 1993) that found that the introduction of Travelcards boosted passenger miles in the first year, by 3.83%, is based on very aggregated time series data. We question what other control variables were included. The paper by Foote and Darwin (2001) for Chicago concludes that a 3.6% increase in ridership over a year when automated fare collection (AFC) was introduced is attributed to many factors but most is attributed to fare policies within a single mode (which is more reflective of where the market is). Indeed the overall growth impact (i.e., new trips) of all sources of fare changes is maximally 30% of 3.6 or 1.08%. Clearly much less than 10% suggested by the BAH review.[51]

The Dutch rail–taxi combination introduced in 2000 is another example of integration of two modes. One cannot infer anything about patronage growth because the new taxi services provided were rather different from those of the ordinary taxis. The train–taxis have a lower quality of service. With more passengers per taxi, one may have to wait at the railway station. Another example is the introduction of the standardised nationwide bus/tram/metro ticket in the Netherlands in the 1970s enabling passengers to use the same ticket irrespective of the mode or the company providing the services. There was no monitoring undertaken on the effects of its introduction at that time. Such changes tend not only to encourage integration but also produce a different price structure.

5.4. CONCLUSIONS

The arguments and evidence presented herein suggest that the perceived gains from the reduction in the number of contract areas are likely to be illusory. If the gains in network economies are not sufficiently large to outweigh any likely loss of internal efficiency there is a case for amalgamating contract areas to ensure that local services are not hampered by cross-contract area constraints on service delivery. Given the major focus on local service provision, opportunities to deliver appropriate cross-regional and cross-network services can be revealed and promoted by partnerships between bus operators and the regulator.

What is required is a mechanism by which the appropriate market signals are captured and made available to all relevant parties (i.e., the release of information). Integrated fares as one instrument to promote network public transport activity, while having some merit, are unlikely to be a major influence on the take-up rate of cross-regional network services since they are best supplied as a single modal service through an alliance or agreement for a single operator delivering cross-contract route-specific services where transfers are minimised if not eliminated. Then and only then might we have a chance of taking some traffic from the car market.

APPENDIX 5A. THE IMPACT OF FARES AND TICKETING INTEGRATION ON PATRONAGE INTERNATIONAL CASE STUDIES

Source: Booz Allan Hamilton Review (2002)

London

As part of a number of initiatives to increase public transport use, multi-modal Travelcards were introduced for bus and underground services during early 1983. Rail was later included in the scheme with the merging of Travelcard and Capitalcard during 1989. Fairhurst (1993) sought to separately isolate patronage impacts from changes in fares and fares integration. The first year impact from fares integration was significant with passenger miles increasing around 18% on buses, 28% on underground services and 24% overall.

Paris

In mid-1975, the 'Orange Card' was introduced in the Paris region. The card is a non-transferrable, monthly (or yearly) season ticket, which can be used on different transport modes including bus, the metro and suburban train and various operator networks (i.e., RER, SNCF, APTR). The 'Orange Card' has had a significant effect on patronage although the impacts on bus and Metro services have been disproportionate.

New York

A major change in ticketing occurred in New York during 1997 with the introduction of the 'MetroCard'. The 'MetroCard' is a stored value card that can be used on the bus and the subway and is accepted by all operators. The 'MetroCard' had a significant effect on patronage, particularly buses. Between July 1996 and July 1997, average weekday bus ridership increased 16.9% and average weekend bus ridership increased 20.2%. The effects on the subway were less marked, with weekday subway ridership increasing by 2.6%. Overall ridership levels were at their highest since 1971 (Walker, 1997).

Zurich

Prior to the introduction of integrated ticketing, Zurich was characterised by an exceptionally high level of public transport use. Schedules were co-ordinated on a voluntary basis with each operator having their own fares.

After the formation of the Zurcher Verkenrsverbund (ZVV), a comprehensive integrated fare and ticketing system was introduced. This involved the full co-ordination of services and the development of a single fare system based on zonal fares. The combination of these two factors increased overall patronage by an average 12% in the first 2 years of operation, with significant increases of 53% and 30% for feeder buses and heavy rail, respectively (Laube, 1995).

Surrey

Surrey County Council has made significant investments in several public transport schemes including the Travelwide ticket in Woking. User surveys were conducted to evaluate the performance of such schemes. Surveys revealed that the Travelwide ticket had little effect on patronage in terms of take-up by existing users (i.e., less than 2% of bus users had used the Travelwide ticket). The Travelwide ticket was found to have had limited success in generating new bus journeys. Overall, the study concluded that the multiple journey 'Travelwide' ticket had a negligible effect on patronage (Anonymous, 1993).

Los Angeles

Inter-operator transfers accounted for less than 0.5% of total regional rides prior to the growth of fares and service integration. As service and fares integration grew, the number of passengers making multi-operator trips increased. By 1994, the number of multi-operator trips had increased by 2% (i.e., 11 million boardings per year) (Carter & Pollan, 1994).

Chicago

A Chicago study estimated that ridership would increase between 2 and 5% as a result of the introduction of automated fare collection systems (Dinning, 1996).

West Midlands

One of the first major examples of integrated ticketing in Britain was the West Midlands Travelcard scheme introduced in 1972. As a result of the scheme it was estimated that 7% more trips were being made by 1981 (White & Brocklebank, 1994).

Singapore

Over 1991–1992, the 'Farecard' system in Singapore increased passenger numbers by 2.5%. Given the increases in fare levels this outcome was not anticipated (Baggaley & Fong Choon Khin, 1994).

APPENDIX 5B. CONTRACT AREA SIZE: THE ADELAIDE VIEW

Tom Wilson
Passenger Transport Board, Adelaide

Our limited experience in Adelaide was that there seemed to be little interest from tenderers in contracts with less than 30 buses (the Outer NE Transit Link Contract for 25 buses, for example). Of course, there are many arguments about bus depot size, but a large contract can easily have a number of depots.

As someone who largely designed the shape/size/boundaries of our Adelaide contracts, I would suggest that the most important issues are:

- Closely examining the structure of the existing route network to see how it fits together, and where the natural breaks and boundaries are.
- Examining geographic boundaries.
- Examining passenger travel patterns as well as having a knowledge of non-public transport (but potential) travel patterns.
- As the main all-day public transport passenger flows in Australian suburbs are primarily to the City and to major regional/district centres, these centres (and major interchange points) should form the focus points of contract areas. They can either be in the centre of them, so the contract area surrounds and focuses on them, or on the boundaries of two or more contract areas, so that each adjacent contract area can focus on those centres. The trade areas of these centres is therefore an important element in contract area design.

- Allowing cross-boundary services to continue, and ensuring that new cross-boundary services can be implemented by writing their possibility into the contracts. Cross-boundary services should generally be allocated to the contract area within which most of the route falls.
- Alternatively, very long cross-boundary routes could be treated as separate 'route' contracts, providing a significant number of buses involved.
- Small route groups that do not comply with all of the above should be amalgamated with the larger area contracts to allow flexibility in network planning. They could be retained if necessary where they serve an isolated area – e.g., a suburban area on one of Sydney's many peninsulas could have its own contract without impacting on flexibility.

This page intentionally left blank

CHAPTER 6

PERFORMANCE-BASED QUALITY CONTRACTS IN BUS SERVICE PROVISION

6.1. INTRODUCTION

Passenger transport is characterised by significant market failure, particularly related to the existence of unpriced external costs of private car use. These externalities include issues of social disadvantage, environmental damage and safety concerns. Recent Australian research on the subject of the external costs of road use, for the Bus Industry Confederation (BIC, 2001), indicates national costs of $30 billion but offsetting revenues from road users of only $11.5 billion. The majority of the external costs are incurred in urban areas, which experience substantial levels of traffic congestion and where peak-period car use is substantially underpriced. Questions of social disadvantage were not included within this analysis for BIC and would be an additional source of concern.

The existence of these external costs is reflected in governments around the world seeking more sustainable means of meeting passenger transport requirements, including support for public transport because of:

- its capacity to meet social obligations (e.g., provision of transport options for transport disadvantaged groups); and,
- its capacity to reduce the (unpriced) external costs of private car use for all sources of intra- and inter-sectoral externality.[52]

To optimise the performance of public transport in meeting passenger transport requirements and reducing the external costs of private transport, these dual roles need to be reflected in the contractual arrangements that govern public transport service delivery. This can be done by using remuneration systems that separately reward service providers with respect to:

- the community service obligations (CSO) of government in public transport service provision, at efficient cost levels (achieved through best-practice benchmarking); and

- an incentive component related to the public transport user benefits and additional external benefits from attracting passengers from private cars to public transport flowing from service improvements.[53] The public transport user benefit component is an important ingredient since, under regulated fare environments, operators are constrained in their ability to be rewarded for user benefits that flow from their service initiatives. The external cost component is vital because of the scale of these costs from road use and the urgency to take action to reduce them, as part of the development of more sustainable land transport systems.

In this chapter, we set out the rationale for performance-based contracts (PBCs) as a way of delivering social and environmental outcomes consistent with government policy, recognising the financial stringencies of public budgets and the need for appropriate incentives for operators to deliver value for the subsidy dollar. Importantly, we recognise the need to ensure that public funds are efficiently allocated at a system-wide level. While PBCs as a concept are not new (e.g., farebox contracts already exist), the delineating feature herein is that payments above CSO levels are based on social and environmental benefits rather than primarily on commercial considerations. In addition, we recognise that any contractual process must be capable of being regulated in an administratively efficient manner without adding unreasonable burdens on the regulator. A formal framework within which to establish the incentive payments, given the total subsidy available and social objectives of government, is developed in Hensher and Houghton (Chapter 7). To avoid detracting from the main theme we have added informative comment in a series of footnotes.

6.2. THE APPEAL OF PBC

The 1990s saw a noticeable increase in competitive tendering (CT) of a range of services that had previously been supplied by governments, mainly driven by pressures to reduce the budget cost impact of service provision. The focus was thus typically on minimising costs to government (under the label of cost efficiency), rather than on delivering specific service quality outcomes.

The Scandinavian experience in recent years is particularly revealing. Experience with CT suggests that it can help to reduce costs but it is by no means necessary to achieve this objective. Institute of Transport Economics (ITE) (2000) reports that about 80% of publicly served routes in Sweden and Denmark are open to tender; in contrast the figure is 7% (as of July

2001 – see Carlquist & Frøysadal, 2001) in Norway. However, "there is no indication that public transport operations in Norway are less cost-effective than those in other Scandinavian countries and the level of subsidy is much lower" (ITE, 2000). According to Carlquist (2001), the *possibility* of tendering per se in Norway seems to have delivered sufficient impetus for cost reductions.

Preston's (2001a, 2001b) review of CT in Europe brings out the tendency for public monopoly in service provision to be replaced by private monopoly, with a small number of the same monopolists recurring in different locations (including Australia). This development in erosion of a large number of players and replacement with a few large players is a cause for concern, since it opens up the greater possibility of the regulator being 'captured' by the monopolist, as may perhaps be argued to be happening with the train and tram franchises in Melbourne in 2002 and a gradual upward increase in contract prices.[54] In such circumstances, apparent cost savings from CT are open to erosion over time with the added risk of losing control of the overall objective of efficiently allocating the total subsidy budget across the entire public transport system.

PBCs have emerged as a practical alternative to CT in some jurisdictions (e.g., Hordaland, Norway), based on the premises that:

- competitive tendering tends to focus on cost reduction, whereas governments are increasingly recognising the need for much broader outcome objectives (e.g., of the triple bottom line variety involved in reducing the external costs of car use) *and* closer control of total subsidy payments (which is not the same as reducing subsidy support);
- each geographical location is different and in recognition of this, PBCs acknowledge that the experiences to date (especially in recent times) should at the very least be used as the starting basis for determining the first round optimal service and hence subsidy levels under benchmarked best practice costing and appropriate payment incentives;
- a transparent partnership between the regulator and the service provider offers the most effective way of delivering transport services, ensuring that the allocation of subsidy is determined optimally *from a system-wide perspective* not on an individual contract by individual contract basis (as would be required under CT – see below); and
- both parties should share the risks and rewards that a quality partnership can deliver (in contrast, tendering suggests some principal–agent relationship which is not partnership compatible). This is known as bilateral governance (Alexander, 2000).

International evidence supports the view that the good bus operators are much closer to the customer and therefore enjoy market knowledge that is greater than that of the regulator.[55] There do exist ‘bad’ operators as well and hence the onus of a PBC regime is to provide the environment in which all operators can improve their performance by having to operate at best practice costings within an operating setting above minimum service levels (MSLs) and, as a consequence of appropriately structured incentive payments, they are then likely to seek out new opportunities to grow the market. Performance-based contracts recognise this expertise and are structured via incentives to harness the expertise so that customers and the wider community can reap the benefits. Operators who are not able to operate under benchmarked costs can exercise the option to sell up. To ensure the incentive scheme is effective, there is a case for considering a requirement to grow patronage[56] above MSL patronage by an agreed annual percentage (i.e., a growth target) or face having the contract subject to CT. Reviewing MSLs will be an essential element of the PBC process to ensure that the MSLs, as a base above which incentive payments are established, remain appropriate to the needs of a contract area.

The idea of PBC is not new and has received strong and growing support in Europe, especially in Scandinavian countries (Carlquist, 2001; Johansen, Larsen, & Norheim, 2001), where several regional authorities in Norway have rejected competitive tendering except as a last resort strategy (i.e., non-compliance under PBCs).[57] The focus of PBCs is on getting the right incentives in place to ensure that subsidy allocations (and hence service levels) are optimal from a *community perspective*, encompassing CSOs, public transport user benefits and external cost reduction. The idea is simple: individual operators are offered a subsidy per vehicle kilometre for the provision of MSLs and an incentive payment in the form of a subsidy per passenger trip for passenger numbers above the trip numbers associated with the MSL, in return for delivering a level of service and fare regime that satisfies both the social obligations of government and the commercial objectives of operators. Importantly, the subsidy levels established under PBC contracts are derived from social and environmental criteria and not commercial criteria, but they recognise that the latter must be taken into account if an operator is to deliver value for money in the way they use subsidy.

If CT specifications are defined in the same way as a PBC with a bid to deliver the CSO MSL and a bid to deliver additional passengers at a subsidy dollar per passenger (distinguishing the user benefit and externality benefit dollar rate), they might be seen as approaching the optimum social outcome that PBCs offer. This necessary condition is that *the entire set of contracts awarded under CT have hit on the right levels of service and fares so as to maximise social surplus* while delivering normal profits (i.e., not excessive profits under the total system-wide subsidy cap). This would be an accidental outcome of the CT process, rather than being the intended result it would be under a PBC regime as proposed in this chapter. If a similar outcome were to be pursued by subsequent negotiation between the regulator and prospective winning tenderers, to better approach a social optimum across a full set of tenders in an area, this begs the question of why competitive tendering was attempted in the first place! One might just as well proceed straight to direct negotiation with existing service providers for a PBC. In Hensher and Houghton (Chapter 7), the idea of PBCs is developed and implemented system-wide within the Sydney context for outer area service providers, as an illustration of how the approach would work in practice.

Unlike CT as we know it, PBCs do not dictate the details of specific service levels (at least above MSL)[58] but rather encourage the operator to build on their knowledge of the market to move service levels to those that deliver the best value for the subsidy dollar. Competitive tendering is not excluded from the contract regime, rather it is used as an effective instrument to protect the market of consumers if an operator defaults on the delivery of service levels that arise from determination of optimal subsidy outlays.

Competitive tendering is market driven at the time of bidding but generally provides the wrong set of incentives to do more in line with social obligations or external benefits. The market will not identify (or guarantee) the optimal level of subsidy as derived from a social surplus maximisation model in which profit maximisation and external benefits are both taken into account. This is especially problematic at a system-wide level, where the need to establish an incentive payment scheme taking into account all services in a geographical jurisdiction (e.g., a metropolitan area) is crucial to the calculation.[59] Competitive tendering is focused on individual contracts with no mechanism to ensure that the incentive payment support sums to the optimal subsidy commitment across a broader geographic area. This is the area where PBC is much better because it takes advantage of the market, the obligation on delivering value for money spent from taxpayers in the form of optimal subsidy and external benefits. If bidders under CT are offering prices that comply with profit maximisation, then this is taken into account under PBCs but within a framework in which profit maximisation must comply with conditions of social surplus maximisation.[60]

To these points can be added the concern that CT is open to the regulator being captured by powerful monopolist providers, a particular concern as the number of operators diminishes with global purchasing. Provided remuneration of operators under PBCs is based on efficient cost benchmarks, government objectives might be better delivered in this contracting environment (under a transparent partnership) than under competitive tendering.

There might be some concern that rejecting CT in favour of PBCs will entrench existing franchised service areas,[61] when perhaps some re-arrangement of these areas would better achieve social goals from service provision. PBCs depend on partnership relationships, both between individual operators and the regulator and *between the set of operators and the regulator.* One condition for the regulator agreeing to a system of PBCs across a region or area, where these PBCs are not delivered by competitive tendering, should be acceptance by the industry of operators in the region/area that, if strategic planning processes suggest a restructuring of service franchise areas, the industry will negotiate the change among participating operators. Provided the industry is closely involved in the strategic planning processes, this condition of PBCs is a reasonable price for certainty. This is the approach being explored by the bus industry in Victoria, Australia (in a setting where most bus services were initiated by the private sector decades ago).

6.3. THE HORDALAND (NORWAY) AND NEW ZEALAND MODELS: A HEALTHY STARTING POSITION

Norway and New Zealand (NZ) provide leading edge examples (as of 2001) of how performance-based approaches to public transport delivery can be structured at the urban, regional and rural levels. The aim in both cases is to give greater effect to the economic rationale for service subsidy, namely bringing operations more into line with social surplus considerations. Benefits to existing and new users from service improvements are rewarded and there is also a prospective reward for reducing external costs.

6.3.1. Hordaland

Hordaland[62] is one of the three areas in Norway where performance contracts (called 'quality contracts') are being implemented for public transport service provision. The contracts start from the premise that the operator usually has the best knowledge of the market and should be left to design the most appropriate route system. However, for this system to be designed and operated effectively from a social perspective, proper incentives need to be present. The contracts recognise that a profit maximising operator, in making decisions about service changes, will normally only consider the direct marginal implications for costs and fare revenue. This misses two important elements from a social surplus perspective:

- the benefits to existing public transport users from an improved service level (these are essentially an externality to the operator); and
- the benefits from reducing car use, when that use is 'underpriced' in terms of its marginal social costs.

The Hordaland framework seeks to internalise these benefits within an operator remuneration framework that is related to the level of service and to passenger numbers (see Johansen et al., 2001 for a formal economic treatment).

The key principles in the PBC introduced in year 2000 are firstly, that the operator is given financial incentives for product development. Secondly, the authorities define a framework comprising overall quality requirements regarding price, service and accessibility. The County may cancel the contract if the operator fails to fulfil the pre-determined criteria. Joint co-operation is required for the contract to be fulfiled and the authorities are obliged to enforce measures to improve the effectiveness of the public transport system (e.g., with respect to matters such as bus priority treatment).

Public transport, considered as a public good, requires incentives additional to those from the market place to avoid a level of production lower than what is (welfare) economically effective. Such incentives apply in the Norwegian approach for minimum kilometres, for example, with regard to school buses and other socially necessary services, although this may be granted as a fixed subsidy. More importantly, it applies for increasing frequency and vehicle kilometres, which implies gains for existing passengers as well as attracting new passengers (modal shift). This is especially valid for peak hour passengers, when the marginal costs of extra departures are high.

Larsen (2001) and Johansen et al. (2001) present the modelling on which the Hordaland contract remuneration system is based. Fare levels, bus revenue–kilometres and bus capacities are chosen so as to maximise a social welfare function. Fare subsidies and revenue–kilometre subsidies are then calculated so as to induce a revenue maximising bus operator to select the socially optimal levels of revenue–kilometres and bus capacities. Fares are regulated by the County but the total payment per passenger received by the operator is the sum of the fare and a subsidy component.

In Hordaland, the *entire* subsidy amount is performance based. There are specified rates for subsidies per route kilometre, per vehicle hour for peak hours and off-peak.[63] An additional amount per passenger in peak hours was suggested but not implemented. These rates vary among operators, depending on the proportion of urban versus rural kilometres. In principle, there is no upper boundary for any of the given subsidy components, but due to budgetary constraints in the County there is a ceiling for the total amount granted.

The authorities define a framework for the minimum quality of service, with regard to fares and accessibility. This also involves a customer satisfaction survey.[64] If customer satisfaction falls below 90% of the target level, the authority, Hordaland County Council, can cancel the contract and select another operator.

The operators are granted a substantial degree of responsibility for planning and product development. They decide on timetables and frequencies, vehicle types and fares, that is, elements belonging to the tactical level, not only the operational. The authorities define certain minimum criteria, and otherwise do not intervene at the tactical level. The operators are free to establish and withdraw routes except for school buses. However, they cannot reduce the number of overall network kilometres without the prior consent of the County.

A commonly voiced argument against performance contracts is that they protect the incumbent. In Norway there have been two ways to handle this. Firstly, a 'threat of competition' has been included in the contract: If service quality drops below a specified level (e.g., a customer satisfaction index), the authorities may tender the contract. Secondly, as is the case in Grenland (a city in Telemark County), the performance contract itself will be tendered. This competition will not follow the 'lowest bid wins' principle. Instead, a fixed amount of subsidy will be offered, and a multi-criteria method will be developed to select the operator offering the best service (i.e., in terms of delivered quality, frequency, vehicles, etc.). This principle is consistent with the value for money approach outlined in Hensher and Houghton (Chapter 7). The Grenland contract will be implemented in 2003/2004.

6.3.2. New Zealand

Transfund New Zealand has recently developed a Patronage Funding policy for public transport that provides direct incentives for patronage growth.

Central Government public transport funding to the NZ regions (not to operators direct) is based on:

- matching base funding levels that existed in 1999–2000;
- 'kick-start' funding of a share of the costs of approved new services and initiatives; and
- a patronage incentive.

The patronage incentive is based on the same two components included in the Hordaland model, user benefits and externality benefits of improving services and gaining new passengers. Wallis and Gale (2001) report that the externality component includes estimates of benefits from reduced road congestion plus an allowance for safety and environmental benefits. As a consequence, the payments vary by city, time period and distance travelled. Thus, for example, payments are higher for peak period patronage increases in more congested cities than for off-peak patronage increases in cities with little traffic congestion.[65] The approach is unambiguously intended to direct funding towards locations where public transport improvements can make a difference in reducing road congestion.

To seek some cross-sectoral parity with funding of road improvements, a shadow-price (or 'hurdle rate') of funds is introduced into the funding formula, such that only public transport projects that achieve a marginal benefit–cost ratio (BCR) similar to, or better than, that of marginal road projects which receive funding will be supported. The shadow-price is introduced as the value of the marginal BCR for funded road projects, this being used as a divisor of the public transport benefit measure (user benefits plus external benefits from public transport improvements).[66]

The values of the externality benefits in the New Zealand work are presented by Wallis and Gale (2001) as follows:

- environmental and safety benefits are typically in the range of 8–13 cents per marginal passenger kilometre, across all centres and peak/off-peak;
- congestion benefits vary by city, reflecting congestion levels, and are only significant at peak periods. Values were in the 40–50 cents per diverted passenger kilometre for the peak in the largest two cities of Auckland and Wellington.

Benefits to existing public transport travellers from service improvements were expressed as a function of the generalised cost (per passenger) of travel by public transport, which was assessed as

$$G = \$2.65 + \$0.48 \times \text{trip length}$$

Dividing this expression by the elasticity of demand with respect to this generalised cost produced the relevant benefit estimate. Elasticity values were put at −1.0 for peak periods and −1.5 for off-peak.

6.3.3. Assessment

The Hordaland and New Zealand approaches provide a valuable start towards the development of a PBC remuneration system that reflects the service delivery goals of the governments that are providing service-funding support. In particular, they direct attention to a support framework in which the social goals of generating benefits to existing public transport users and reducing the external costs of road use are embodied.

The New Zealand approach also includes external benefits from service improvements but it does not deal with the question of defining a minimum public transport service level that might be required in recognition of the CSO function of public transport.[67]

The framework developed in Hensher and Houghton (2003) for Australia integrates all the ideas from Hordaland and New Zealand (with some variations) to optimise service delivery and subsidy provision across the CSO component, the additional benefit items (user benefits plus external benefits), and operator returns.

6.4. A PROPOSED PERFORMANCE-BASED QUALITY CONTRACT REGIME FOR AUSTRALIA

The proposed PBC regime has evolved in recognition of government concerns in many jurisdictions to ensure that public transport is delivered in such a way that it fulfils a broad set of social values and social obligations. In particular many governments promote the use of public transport, promote less use of the automobile, and promote financial support (through direct subsidy) to public transport operators that delivers value for money to the community as a whole.

Such governments recognise that public transport should be promoted to all where it makes sense (see Hensher, 2002), and that it has a particular role to service those less able to use other forms of transport (the equity argument). The equity argument translates into support for MSL. Compliant with appropriate levels of CSO associated with MSL, there is a belief that providers of public transport can grow their patronage (see Hensher, 2002) by providing levels of service and fare profiles beyond that which might reasonably be subject to CSO determination (the latter defined in terms of a minimum amount of annual vehicle kilometres (VKM) and a maximum fare regime, the VKM regime determined through some formula based on population to be served, population density, and other agreed criteria). Such patronage growth will be associated with use benefits to public transport patrons and additional environmental benefits from lowering the external costs of private car use.

Government can contribute through *a regulatory partnership* with public transport providers by supporting an appropriate incentive-based contract regime that rewards improved performance, while setting acceptable lower limits on service delivery that, if not provided, may subject the incumbent's contract area to CT. Competitive tendering, as traditionally structured, as the immediate 'solution' to market, and regulatory performance has not been successful in delivering better value for money while also growing the market of public transport users and reducing automobile use. PBCs of the form described below offer an alternative regime.[68] Indeed, CT has fewer degrees of freedom in encouraging an operator to grow the public transport market and deliver increasingly better value for money in respect of subsidy outlays compared to PBCs.

The contract regime proposed herein builds on the models in place in New Zealand and Norway (set out in Section 6.3) but is an improvement on both in that it avoids arbitrary starting levels of service and fares and uses best practice costs (in contrast to New Zealand) and takes into account the importance of partitioning the incentive payment scheme to recognise a MLS (dictated by a CSO regime), a user benefit (delivered through benefits in costs and service levels to all trips above MSL levels) and an externality benefit through switchers from car (primarily) delivering improved levels of traffic congestion, noise, air quality, greenhouse gas emissions, safety, etc.). In contrast to the Norwegian model, which has an unconstrained subsidy budget, we suggest that the subsidy must be capped for political reasons.

The proposed PBC recognises, in the specification of a contract, two crucial elements:

1. A CSO (linked to MSL as defined by VKM, as determined by criteria such as population, population density and incidence of school children in the population). An MSL grading is provided. The financial impost to government will be a dollar per VKM applied to total VKM required for each of the peak and off-peak by a specific grading, based on costs that are benchmarked as efficient.

2. A patronage incentive (PI) to deliver passengers above those who will use the service at the service and fare levels consistent with CSO MSL. The incentive takes the form of dollar per passenger and incorporates two elements: benefits to existing and new public transport users from service improvements and reductions in external costs of car use for modal switchers ($/passenger converted from car use). Any financial support tailored specifically for schoolchildren is scrapped since school children are also subject to the same incentive payment system as other passengers.

The determination of the level of the financial incentive is based on the following conditions:

(a) A system-wide (e.g., metropolitan area) total budget or subsidy (TB) is determined by government as part of its broader budgetary determination process. The amount of TB might be determined on an annual basis, with review as to its increase or decrease over time. This is $per annum of TB.
(b) The total patronage incentive is defined by TB-$CSO and is calculated at costs benchmarked as efficient. Once this is determined there is no more available to be allocated to the incentive payment scheme.
(c) The $CSO payment is defined by $/VKM × VKM for all operators (using the grading classification to define an operator-specific VKM or MSL).
(d) In determining the optimal incentive payment (or optimal subsidy) per additional passenger, Hensher and Houghton (Chapter 7), in active consultation with industry, has developed a simple calculation template which solves for the optimal incentive payment by taking into account the cost of providing existing and additional service levels, the change in demand associated with improvements in service levels, the TB available, the sum of subsidy support system-wide available after CSO obligations are financed, the benefits to users from increased use of public transport, and the externality benefit to society of reducing car use. In addition, and in recognition of a desire to ensure that public transport providers act efficiently and at best practice, the cost inputs are based on benchmarked best practice and there is a constraint that the total (best practice) cost must be covered by all sources of revenue (i.e., CSO + fare + PI payments) with an acceptable return on investment built into costs (i.e., normal profits). It is assumed that best practice costings (e.g., total cost per kilometre) apply to both CSO and above-CSO service and fare level determination.

(e) Given the best practice cost regime (peak and off-peak), demand profiles (peak and off-peak), TB and CSO determination, and the normal profit constraint, we are able to establish a PI per passenger for both gains in patronage, that is, growth attributable to any source, plus an additional payment per passenger if they are attracted out of car and deliver reduced VKM for car travel.[69]
(f) The externality benefit will be derived from known benefits to society through reductions in congestion etc. as defined by $/VKM of car use.[70] These unit benefits are available from the literature (as derived from willingness to pay studies).
(g) To determine the amount of switching from car we propose a simple application of a cross-elasticity[71] for the respective change in service level (i.e., PT VKM) and/or fares. We will also recommend an appropriate reduction in car VKM for specific PT operating environments. A switcher from car to PT is assumed to be an ex-car user for the period of 12 months. After that they are deemed to be a non-switcher.

The proposed scheme requires a limited number of data items from the operator, all of which are readily available.[72] Costs as determined by best practice and patronage data, fares and service levels can be obtained from existing sources (e.g., The Institute of Transport Studies benchmarking programme). Additional inputs such as fare and VKM elasticities for peak and off-peak activity are readily available as are the unit benefit rates for reductions in externalities per VKM for car use.

Hensher and Houghton (2005, and Chapter 7) have developed a case study to demonstrate the appeal of PBCs over CT as a simple and meaningful way of growing the patronage market from any sources but especially from existing car users, which will operate within the limits of budgetary support from government, ensure CSO compliance and optimal subsidy allocation above the CSO support. The incentive structure is transparent and consistent with global views on the delivery of sustainable transport for sustainable futures.

6.5. CONCLUSION

Performance-based contracts align contract specification closely with the intended policy outcomes from public transport service provision. This will increase the prospects of successful achievement of the intended policy outcomes. The approach will be of great value to government since it will generate data on the social benefits of alternative service level changes, data that will assist government in its determination of the most appropriate level of total funding (TB). It also will encourage development of co-operative partnership relationships between government and operators in service delivery, whereby both parties share the risks and rewards involved in spending the taxpayers contribution to achieve maximal benefit, while the community's transport services are made more sustainable long term. The partnership and the trust relationship are crucial to the success of PBCs. The non-operator has as much responsibility to support patronage growth as the operator.[73]

CHAPTER 7

PERFORMANCE-BASED QUALITY CONTRACTS FOR THE BUS SECTOR: DELIVERING SOCIAL AND COMMERCIAL VALUE FOR MONEY

7.1. INTRODUCTION

Over the recent period of significant change in how bus services are supplied in many countries, a key focus has been the delivery of cost efficient services (through mixtures of privatisation, economic deregulation and competitive tendering (CT)) and finding ways to grow patronage (Hensher, 2002a). Despite all the developments to improve the cost and service efficiency of operations, something has often been shown to be lacking – the global picture-which recognises that public transport is, above all, provided through a supply chain in which more than one objective applies, such as commercial and social obligations. This more holistic approach, as presented in Hensher and Macario (2002 and Chapter 2), recognises that no institution is able to act without affecting the other agents in the system. Social surplus maximisation (SSM) principles applied to transport tend to suffer when the focus is narrowed to the detail of cost efficient operations (the dominating focus in recent years of CT), losing to a growing extent the SSM aim associated with an overall mobility system. A big challenge is to re-focus on the integration of SSM and commercial objectives in a way that delivers much improved service levels as part of what might be generically termed *a value for money* (*VM*) *objective* function. The holistic vision is to pursue social planning with a commitment to commercial objectives and opportunities at the operational level under a cost *and* service efficiency regime, thereby recognising the real meaning of optimum subsidy. This theoretical approach is not new and was articulated in the public transport context over 18 years ago by Jansson (1984), and more recently by Jansson (2001).[74]

As part of the many reviews of the contracting regimes that bus businesses operate within, it has been recognised that the relationship between commercial and social objectives has rarely been investigated in a systematic manner. To what extent are existing subsidy support levels optimal? What exactly does this mean? Many governments argue for the role of public transport subsidy as a way to support objectives to shift personal travel from personal automobile to bus in order to reduce external costs, such as traffic congestion, crash risk and negative environmental impacts (Hensher, 2002a). Thus an important task in the review of a service delivery regime is the establishment of an optimum *system-wide* subsidy system for the provision of bus services, such that a profit maximisation level of passenger trip activity on the part of the operator will coincide with SSM objectives. Economists, when integrating these two maximisation objectives, refer to social surplus (SS) maximisation as the sum of producer surplus (PS) (maximisation) and consumer surplus (CS) (maximisation). The former is equivalent (under a cost-efficiency regime) to profit maximisation for private bus operators.

One of the most innovative payment schemes designed to secure socially optimum behavioural responses from transport operators has been developed in Norway, for application in Hordaland County.[75] The local government makes payments to the bus operators through an incentive scheme that "pays for results rather than shares the costs of inputs" (Carlquist, 2001).[76] The approach identifies a set of 'external' effects that are typically not taken into account by the individual traveller when choosing a transport mode.[77] Hensher and Stanley (2003 and Chapter 8) provide more details on this scheme as well as other approaches to the establishment of performance-based contracts (PBCs).

When a traveller chooses to go by car, the decision-maker typically ignores the external costs imposed on others (e.g., the costs of congestion, accident risk and pollution) – assuming (as usual) that the institutional context does not allow the deployment of (first-best) car-user charges to reflect these costs. Conversely, an extra traveller who goes by bus (or other public transport) helps to create a *positive* external effect – often called the Mohring effect: as patronage increases on a route (or in a particular area), the (socially) optimum service frequency also increases. This benefits the new travellers (whose patronage has led to the service improvement), and also reduces trip time for those others who continue to use the service.

In the absence of practicable price discrimination, the operator is not able to extract the increase in CS that is enjoyed by the continuing users as a result of the increase in frequency – because a fare increase for all passengers would preclude some or all of the extra travel that justifies and requires the extra frequency. To achieve the optimum service level, a government-funded incentive payment is needed. To the extent that the incentive payments result in lower fares and/or improved service levels, there can be social benefit from increased travel (that is, generated trips) as well as from the reduction in car travel. This too should be recognised in establishing the incentive payments.

The apparent conflict between the operator's objective function and that of SS maximisation is primarily related to the absence of the use of benchmarked best practice costing and the presence of externalities, linked to environmental (e.g., congestion, pollution) and social (e.g., equity) impacts that are not internalised in the operator's profit and loss account. If SS maximisation imposes a substantial financial loss on the operator, it would be unacceptable to the operator. If however a positive change in CS (based on private user benefits) and non-internalised environmental benefits (EB)[78] would increase revenue (and conversely decrease revenue for a negative change in CS and EB), the operator would have the necessary incentive to act as a SS maximiser. The question then becomes one of identifying how this incentive can be provided in practice. The implementation 'solution' appears to lie in changes to the pricing (i.e., fare) and/or supply regulations in a way that opens up opportunities for the operator and the regulator to seek out incentive-based mechanisms that reflect the challenge to internalise CS and EB.[79] This should hopefully provide the necessary freedom and (positive) incentives for the operator to pro-actively participate in pricing policy and service design to increase cost and allocative efficiency. The benchmark for progress however is internalisation of CS and EB, achieved by the mix of internalised cost recovery and externalised funding by the provision of an optimum subsidy (or incentive-payment).

What formula will work in practice that is acceptable to both the operator and the regulator? One thing is almost certain-there will need to be a transparent level of subsidy.[80] If a scheme is to work, however, it must prevent cost inefficiency (which can be a product of subsidy support, as indeed can poor service delivery). An effective monitoring and benchmarking programme is critical[81] to ensure that cost inefficiency does not occur as the subsidy is introduced to support initiatives that deliver CS, and that external funding delivers the best VM. Periodically reviewed benchmark best cost practice associated with specific geographical settings should be the basis of subsidy determination.

The following sections of the chapter review the elements of a VM regime within the setting of an incentive-based performance contract, and develop a formal (economic) framework for establishing an optimum subsidy based on maximisation of SS. The maximisation of SS is subject to a number of constraints including the commercial imperative of the operator, minimum service levels (MSLs) and a fare and subsidy budget cap. An important feature of the performance-based quality contract regime is a passenger-based incentive payment scheme, incorporating a subsidy per additional passenger trip above that patronage delivered under minimum service and fare levels. In this way, rewards to operators are revealed through the fare box, through increased CS and through reductions in negative externalities associated with car use. The implementation of PBCs is illustrated using data collected in 2002 from private operators in the Sydney Metropolitan Area. PBCs can be designed to accommodate both transition from an existing regime and post-transition growth strategies.

7.2. INCENTIVE-BASED PERFORMANCE CONTRACTS

Before setting out the formal economic framework for a proposed performance-based contract regime, we will take a closer look at a recent initiative in Norway that promotes the PBC regime over CT.[82] New performance contracts were established, in early 2000, for the three bus operators in the Hordaland county. One of these serves the urban area; the other two operate in rural areas and on the main corridors into Bergen. There is little or no on-the-road competition.

The design of the Hordaland payment mechanism is innovative. Larsen and his colleagues (Larsen, 2001; Johansen et al., 2001) develop a two-stage procedure, where the first stage determines fare levels, bus revenue-km and bus capacities to maximise a social welfare function. The second stage calculates rates for fare subsidies, and for revenue-km subsidies (applicable in the peak and/or periods), *that will induce a profit-maximising operator to choose the (socially) optimum levels for revenue-km and for bus capacities*. The operator does not set fare levels but complies with maximum fare levels set by the authority. The per-passenger remuneration received by the operator is the sum of the fare level (determined in the first-stage welfare-maximising calculation) and the subsidy level (determined in the second-stage calculation).

In this approach, a per-passenger subsidy 'pays for results' and the revenue-km payment reimburses some of the costs. The operator also receives the fare revenue and both sources of revenue provide the operator with sufficient income to balance operating costs. In other words, the revenue-km subsidy will not encourage an operator to run empty vehicles. It does encourage service frequency, and the extent of the induced increase in frequency depends on how and successfully the operator pursues profits. This is an incentive-based performance contract where the subsidy is set to match the sum of the avoided external costs of car use *and* the benefits of increased service frequency.

The welfare outcomes depend on the details of the implementation. The implementation of the Hordaland model is described in Carlquist (2001).[83] Each operator has a separately calibrated contract. As in earlier contracts, these are on a net-cost basis; but unlike the Larsen (2001) model, each operator may determine the fare levels. In the event, the implemented contracts do not include any per-passenger subsidy, in part because the (global) budget constraint limited the amounts of subsidy that could be paid.[84] The Larsen modelling had suggested such subsidy should be paid, but only where the fare was significantly less than the marginal cost – as for peak-period rural services. The revenue-km subsidy has been implemented through two components – subsidy rates per vehicle-km and per vehicle-hour-to accommodate differences between congested urban conditions and non-congested rural operations.

The subsidy rates are calculated to secure optimum *marginal* conditions. In principle, there is no certainty that the total amount of subsidy will be such as to enable the operator to receive as much as, and no more than, a reasonable return on investment. Numerical calculations prepared by Larsen show that the urban operator would be likely to receive a substantial level of excess profit. This arises because the marginal cost of the peak services is very much higher than the cost of the other ('basic') services, which are a substantial part of the total offering. Accordingly, a 'fixed deduction' was suggested. Being fixed in total amount, this has no effect on the (marginal) incentive structure. Carlquist reports that the fixed-deduction principle *was* incorporated in the implemented contracts.

In the first year (2001) of the deployment of the new performance contracts, there has been little change especially in regard to route networks; in part because the budget constraint was tight enough to limit the scope for change, and in part (perhaps) because of inertia, including political resistance to change. Nevertheless, Carlquist (2001) reported that experience with the new contracts is generally well regarded.

The Hordaland model has provided the starting position for the authors' proposal for a PBC framework for Australia. The data used to illustrate the implementation of a PBC regime has been obtained from a major private operator who is widely regarded as operating at best practice with respect to cost efficiency and effectiveness. Thus the approach detailed below is indicative of the outcomes one might anticipate under a PBC regime for an outer urban area bus operator in a major city in Australia. We focus on a PBC scheme under a transition from the existing contract regime, but show that once the transition is complete, the very same PBC scheme can be used to promote growth in passenger trips through improved service levels supported by incentive payments and possibly higher levels of subsidy support (Hensher & Houghton, 2002).

7.3. THE AUSTRALIAN PBC PROPOSITION

The proposed PBC framework is based on a model system that recognises the obligations of government,[85] as well as the need to provide appropriate incentives to operators to service the market in line with VM under a tight subsidy regime. In addition, we recognise the constraints under which the regulator charged with implementing and monitoring a contract regime operates. In New South Wales (NSW), for example, a paramount requirement is for a minimum[86] administrative burden, supported by the provision of suitable data from bus operators.

The PBC framework is assumed to be implemented *system-wide* over a pre-defined geographical area. It can also be implemented for a single operator. We distinguish between metropolitan and non-metropolitan settings and focus herein on the metropolitan model. Furthermore, we recognise intra-metropolitan differences in the operating environment, especially due to patronage catchment, traffic congestion and time of day servicing. These differences are accommodated (to a large extent) by distinguishing between inner and outer metropolitan areas as well as peak and off-peak periods. Where MSLs are required, they will be set exogenously for each region and period based on a grading system determined, outside of the PBC structure, by a number of criteria including population, population density and incidence of school children.[87] The PBCs are assumed to have available, ex ante, relevant information on costs and demand conditions in order to calculate MSLs and fares, with the opportunity to measure, ex post, the operator's actual performance (Laffont & Tirole, 1993). This is essential in order to ensure that the right incentives are operating, otherwise operators would themselves have incentives to not reveal the true information (see Pedersen, 1994). All costs used will be benchmarked best practice for the specific context.[88] The use of benchmarked costs is designed to ensure that optimum subsidies are based on cost efficient service levels.[89] In addition, electronic or automated ticketing is essential to track patronage.

7.3.1. Defining Annual Passenger Demand

The demand for bus travel (Y) is defined as one-way annual passenger trips[90] per contract period, and is assumed to be influenced by fares (q) and service levels (X), where the latter is proxied by revenue VKM (i.e., total VKM minus dead running kilometres). Since the categories of bus passengers have differing degrees of behavioural responsiveness to changes in fares and service levels, separate passenger demand models are required for each segment. Within each geographical context, we initially propose separate demand models for peak and off-peak travel for two broad classes of travellers: (i) adults, (fare paying) children and concession travellers (ACC) and (ii) school children (S). Further segmentation can be introduced as required. There are many specifications available to represent travel demand. We have chosen Eq. (7.1) for class (i) travellers, and a separate Eq. (7.2) for class (ii) travellers, where the latter applies when school children do not pay a fare. Before the implementation of the proposed scheme (base case B), demand levels, Y^B, are based on *existing* fares and service levels. After the implementation of the proposed scheme (Application case A), predicted demand (Y^A), is a function of a base demand (Y^B); the direct fare elasticity of demand, the direct revenue VKM elasticity of demand; and operator responses to the scheme through changes to fares and revenue VKM. The elasticities used in Eq. (7.1) for each of peak and off-peak activity are weighted averages across the classes of travellers within the separate demand categories.

$$Y^A_{ACC} = Y^B_{ACC} \exp\left[\frac{\varepsilon^q_{Y(ACC)}}{q^B}(q^A - q^B) + \frac{\varepsilon^X_{Y(ACC)}}{X^B}(X^A - X^B)\right] \tag{7.1}$$

$$Y^A_S = Y^B_S \exp\left[\frac{\varepsilon^X_{Y(S)}}{X^B}(X^A - X^B)\right] \tag{7.2}$$

We initially assume a static representation, with annual patronage response assumed to occur at the specified rate over the period of a contract. For class (i) travellers, the fare elasticities are, respectively, −0.20 and −0.45 for the peak and off-peak periods, and the service (RVKM) elasticities are 0.33 and 0.63. For class (ii) travellers, the service elasticities are assumed to be the same as class (i), on the assumption that the parent traveller decides on the school child's modal activity.

The PBC system requires a base prediction of patronage associated with MSLs.[91] To obtain this patronage, we use the level of RVKM associated with the MSL, and impose a fare level unchanged from case B. The resulting

MSL patronage for class (i) travellers is Y^B as shown in Eq. (7.3) for the ACC segment.

$$Y_{ACC}^{MSL} = Y_{ACC}^{B} \exp\left[\frac{\varepsilon_{Y(ACC)}^{X}}{X^B}(X^{MSL} - X^B)\right] \tag{7.3}$$

In what follows Y^A, Y^B, Y^{MSL} will be used in place of $(Y_{ACC}^{A} + Y_{S}^{A})$.

7.3.2. *Defining Annual Total Cost*

Benchmark cost efficiency is formalised by a set of total annual cost Eq. (7.4) for each period and region. Total predicted cost (C) is defined as a function of benchmarked base cost (calculated from best practice total cost per kilometre); predicted responses in total VKM (including dead running kilometres), predicted changes in total passenger demand (from Eqs. (7.1) and (7.2)), predicted responses in total seat capacity per revenue VKM; and the respective set of cost elasticities for VKM, patronage and bus capacity. VKM is the sum of revenue and dead running kilometres, with the default value in our empirical example for dead running VKM set equal to 12.5% of VKM for both peak and off-peak activity. That is, VKM = 1.1258RVKM. Bus capacity, defined by seating and standing capacity per bus multiplied by the number of buses, impacts on passenger demand through revenue VKM and a service *quality* constraint that indicates how much bus capacity must be provided to satisfy passenger trip demand. This then translates into VKM, which impacts on total annual cost, taking into account the annualised cost of bus capital. The starting passenger trip-demand elasticities with respect to cost are, respectively, –0.32 and –0.20 for the peak and off-peak periods. The equivalent service (RVKM) elasticities are 0.76 and 1.20. The equivalent fleet size elasticity, derived from increased capital charges and applied only to peak periods, is 0.19. The separate cost equation for peak and off-peak periods, for each region and period, has the form of Eq. (7.4).

$$\begin{aligned} C^A = C^B \exp\Bigg[& \frac{\varepsilon_C^X}{VKM^B}(VKM^A - VKM^B) + \frac{\varepsilon_C^{Y(ACC)}}{Y_{ACC}^B}(Y_{ACC}^A - Y_{ACC}^A) \\ & + \frac{\varepsilon_C^{Y(S)}}{Y_S^B}(Y_S^A - Y_S^B)\frac{\varepsilon_C^{\#bus}}{\#bus^B}(\#bus^A - \#bus^B)\Bigg] \end{aligned} \tag{7.4}$$

7.3.3. *Defining the Constraints*

There are a number of constraints that enable us to represent the environment in which the delivery of services satisfies all stakeholders. The key constraints are shown below.

7.3.3.1. *Fare Cap*

A fare cap (7.5) over the contract period for each peak/off-peak period and region is a political reality in most jurisdictions, and in Australia (maximum) fares typically may not increase by more than the consumer price index. The introduction of PBCs must comply with this condition, set herein as a 5% maximum increase per annum. This can be adjusted to suit the political setting.

$$q^A - 1.05q^B \leq 0 \tag{7.5}$$

7.3.3.2. *Vehicle Kilometres (VKM)*

A condition of public transport service delivery often included in contracts is that there is a minimum level of service that must be provided under community service obligations (CSO) at cost efficient levels. These service levels are determined by external criteria set by government such as a requirement to provide a minimum amount of VKM depending on the socio-economic and demographic profile of the region to be served. This profile must be defined by an agreed set of criteria, such as total resident population, population density, the percentage of total population that are school children, and availability of other modes (e.g., a train service) (see Ton & Hensher, 1997). On the basis of a weighted system for each criterion, a minimum amount of RVKM is required for each period and region. The precise geographical allocation of this MSL is a detail of specific contract compliance, and does not impact on the determination of the optimal social solution. This minimum RVKM would ideally be an absolute amount; but for the present application we define it as 67% of current service VKMs.[92] Eq. (7.6) defines the minimum level of service. A total cost per kilometre can be introduced to convert this MSL to a dollar commitment from government.

The proportion of the total subsidy budget (TB) allocated to PBCs in the regulator's scheme is denoted by *R*, which permits variations in the structure of the subsidy scheme between MSL and above-MSL (or PBC) components. Since *TB* is the pure-MSL subsidy requirement, as determined by the CSO, the MSL of a given scheme is defined by the associated *R* value as *CSO**

(1–R).[93] The inclusion of R enables us to assess the implications of various mixes of MSL and PBC service levels.

$$\begin{gathered} X^{MSL} = (0.67)VKM(1 - R) \\ X^{A} \geq X^{MSL} \end{gathered} \tag{7.6}$$

In addition to the fare cap and MSL constraints, government typically has a limited budget to allocate to subsidy support for bus transport. This subsidy cap is assumed to be *a system-wide* constraint within the metropolitan area and applies to all inner and outer metropolitan bus operators.[94] The subsidy cap is exogenously given but adjustable by government decree and has to fund the CSO payments as well as payments directly linked to incentives for growing patronage. The passenger-based incentive payment scheme at the heart of PBC's is made up of gains in CS and externality benefits, where the latter are primarily linked to reductions in traffic congestion due to reductions in car VKMs (see Section 7.3.5.2). For every additional passenger trip above predicted patronage, based on $RVKM^{MSL}$ and associated fares, the operator has the opportunity to secure revenue from three sources: (i) the fare box (ii) the change in CS as a measure of UB and (iii) the change in externality cost from reduced car use. The last two revenue streams are referred to as incentive payments and are part of the total budget commitment to the system as a whole by government. After committing CSO payments, the balance of the TB is available for such incentive payments (constraint (7.6)). While this residual amount is fixed, the estimate of its dollar value per passenger trip of the CS benefit will be determined by the maximisation of the SS function subject to the set of constraints. The dollar unit values of reductions in car VKM are exogenously supplied based on studies of the externality cost of car use (see Bus Industry Confederation, 2001; Sansom et al., 2002). If additional passenger trip growth over the predicted amount per contract period is exceeded, it cannot be funded out of the available incentive payments unless government revises its TB. Nonetheless, all additional fare revenue will be accrued by the operators.

7.3.3.3. Traffic and Capacity

In peak and off-peak periods, the road traffic in which buses operate is vastly different, and to achieve a given RVKM in dense traffic requires the deployment of more buses compared to light traffic conditions. A direct measure of bus-utilization (i.e., traffic) intensity in the period is given by $Z^B = (pers.\#bus)^B / X^B$. Z defines capacity required per RVKM, as determined from the RVKM achieved by the number of buses (# *buses)* allocated to the period in the base case. An increase in base traffic results in a reduction in X^B and an increase in Z, which has the effect of increasing the capacity required, $X^A Z^B$, for a given solution X^A. Z is not a control parameter but simply reflects the traffic of the period in the base case.

Imposing equivalent traffic conditions in equivalent periods (peak, off-peak) to the base case requires

$$Z^A = Z^B,$$

$$\text{or}$$

$$X^A = \frac{(pers.\#bus)^A}{Z^B} \tag{7.7}$$

where # *bus* = the number of buses assigned to the period/region *and* *Pers* = bus capacity (seating + standing).

#bus is assumed to reflect the demand levels of the base period and may be changed with corresponding cost implications. The capital cost of extra buses is fixed to # *bus* unless included with Z. *Pers* is assumed to be single-valued and unchanging. From (7.7) the capacity required for a given solution X^A is given by $X^A Z^B$.

The number of buses may be increased or decreased to provide an upper bound to X^A that is fixed by the number of buses assigned to the period, i.e.,

$$X^A \leq \frac{(pers.\#bus)^A}{Z^B} \tag{7.8}$$

For a given *#bus* value, the bound may be loosened by reducing service quality, as discussed above.

7.3.3.4. Service Quality

Service quality is maintained through the service quality constraint, which in its fundamental form requires

$$\frac{Y^A}{X^A} \leq \frac{Y^B}{X^B} \tag{7.9}$$

This becomes very restrictive for low X solutions, since with X^A decreasing from X^B towards X^{MSL}, Y^A declines towards Y^{MSL},[95] more slowly than X^A is declining. At low service levels, however, it is realistic to allow a decline in service *quality* to reflect an interaction between the declining returns and declining price elasticity of demand as the volume of business declines. In general, it is important to loosen the form of (7.9) through a control variable,κ, which relates to how full the buses are allowed to be on average, given normal operating practices. κ is a measure of service quality with respect to loading and allows the service level to slip. The less restrictive form of (7.9) is given in (7.10)

$$Y^A \leq \kappa Z^A X^A \tag{7.10}$$

The starting value of κ is $\kappa = Y^B/X^B Z^B$ which measures the base trip-rate per unit carrying capacity allocated. κ can be adjusted up or down to control an increase or decrease in acceptable bus crowding levels, thereby providing decreased or increased service quality (loading). Where increased κ is not associated with a reduced volume of business, it should result in increased costs to reflect a loss of goodwill. Solutions incorporating increased values of κ will define an environment within which operators may make normal profits while providing high SS solutions. As in the previous section, optimum operator strategies may take the industry in different directions.

7.3.3.5. System-Wide Constraints

There are two system-wide constraints associated with all regional activity.

7.3.3.5.1. Subsidy Cap. First we have the total subsidy cap (7.11) in which the amount of subsidy available for passenger incentive payments is less than or equal to the total allocated subsidy budget minus commitments to CSO payments.

$$\sum_{\text{region,period}}^{4} P(CS + EB) \leq TB - \sum_{\text{region,period}}^{4} \$CSO(1 - R) \quad \text{for } (CS + EB) > 0 \tag{7.11}$$

Constraint (7.11) states that the patronage incentive must be less than or equal to the subsidy budget above CSO payments for all operators for $(CS+EB)>0$. PBCs allow subsidy payments to be earned whenever $(CS+EB)$ is positive. Negative payments are not part of the performance-based system and are excluded in the modelling. Since both CS and EB are measured from the MSL position, payments are excluded when $(CS+EB)<0$. Although the total $CS+EB$ is realised *to the benefit of the community*, the regulator can exercise the option to pay all of the benefit to the operator or only a proportion. P is the payout rate, defining the proportion of external benefits accrued by bus companies on achieved $(CS+EB)$. This is an important issue since the incentive payment focus does not suggest that 100% of the benefit must be paid to the operator.

Indeed distribution of the full social benefit to the operator may not be equitable and/or financially feasible. What is critical is that the payment distribution ensures sufficient incentive for the operator to improve service levels in order to grow patronage.

7.3.3.5.2. Commercial Requirements. Total cost, including an acceptable return on investment, to all operators delivering bus services must be covered by all sources of revenue (7.12). The commercial constraint (Eq. (7.12)) requiring that operator costs do not exceed revenues may be implemented when only commercially viable solutions are considered.

$$\begin{aligned}&\sum_{\text{region,period}}^{4}[C^A-(qY^A_{ACC}+P(CS+EB))]\\&\leq\sum_{\text{region,period}}^{4}\$CSO(1-R)\ldots\text{for }(CS+EB)>0\end{aligned}\tag{7.12}$$

7.3.4. Defining the Objective Function

The demand and cost models together with the constraint set condition the maximum value of the SS objective function, given in (7.13).[96]

Max:

$$\begin{aligned}&\sum_{\text{region,period}}^{4}\big[(1+P)(CS+EB)+qY^A_{ACC}-C^A+\$CSO(1-R)\\&-(\$CSO(1-R)+P(CS+EB))\big]\ldots\text{ for }(CS+EB)>0\end{aligned}\tag{7.13}$$

CS and externality benefit are calculated above Y_{MSL}. The measure of CS is relatively complex and influenced by changes in demand.

7.3.5. Defining the Benefit Sources

7.3.5.1. Consumer Surplus

The *MSL*, corresponds to the *CSO*, and is defined by a minimum RVKM, (X^{MSL}), and maximum fare charged under MSL (typically the maximum permissible fare). The corresponding patronage level, Y^{MSL}, is established from Eq. (7.1). Y^{MSL} establishes the base patronage *above which* CS is generated, given the current subsidy scheme. We let *CS* denote the level of CS associated with patronage determined by X^{MSL} and maximum fares.

A composite demand variable, G, is defined as a function of both fare level and RVKM. G^{MSL} is determined equivalently to Y^{MSL}. The quantity demanded (i.e., patronage) is related to bus travel attributes, some of which are desirable to the consumer, like RVKM, and others which are undesirable, like price. These attributes may be combined in a composite attribute measure, G, where

$$G^{MSL} = kq^{MSL} + \lambda X^{MSL}; \quad G^{A} = kq^{A} + \lambda X^{A}$$
$$G^{MSL} - G^{A} = k(q^{MSL} - q^{A}) + \lambda(X^{MSL} - X^{A}) \tag{7.14}$$

$k = -1$, and $\lambda =$ community preparedness-to-pay for a 1 km increase in X.

Deriving lambda is a challenge given the absence of empirical studies. However, additional service levels can be approximated by improved service frequency. The TRESIS project (Hensher, 2002 and Chapter 11) suggests a willingness to pay for improvements in service frequency of \$2.66 per passenger trip hour. Given an average speed in the peak period of 24 kph and an off-peak average speed of 30 kph, we can convert the frequency valuation into \$0.11 per RVKM in the peak and \$0.0886 per RVKM in the off-peak for class (i) travellers. For class (ii) travellers the rates are halved.

A corresponding composite demand function gives Y^{A} as a function of G^{A}, etc., and CS is then measured as Eq. (7.15).

$$\begin{aligned} CS = {} & 0.5 \times ABS(Y^{A}_{ACC} + Y^{A}_{S} - Y^{MSL}_{ACC} - Y^{MSL}_{S}) \\ & (G^{MSL} - G^{A}) * \text{if } [(Y^{A}_{ACC} + Y^{A}_{S}) \\ & < (Y^{MSL}_{ACC} + Y^{MSL}_{S}), -1, 1](CS \text{ between } Y^{MSL},\ Y^{A}) \\ & + \text{if } [(Y^{A}_{ACC} + Y^{A}_{S} - Y^{MSL}_{ACC} - Y^{MSL}_{S})(G^{A} - G^{MSL}) \\ & < 0, (Y^{MSL}_{ACC} + Y^{MSL}_{S})(G^{MSL} - G^{A}) \quad \text{if } [(Y^{A}_{ACC} + Y^{A}_{S}) \\ & < (Y^{MSL}_{ACC} + Y^{MSL}_{S}), -1, 1], 0] \ (CS \text{ to axis if negative slope}) \end{aligned} \tag{7.15}$$

Given that increases in fares reduce CS and increases in RVKM increase CS, we have to be careful how we treat the two impacts in the determination of changes in CS. Effective demand results from a balance between q and X. For given parameter values, k and λ, the slope of the composite demand function will be positive or negative depending on solution values, q^{A} and X^{A}. When the slope is negative, as shown in Fig. 7.1, a CS, $G^{A}ABG^{MSL}$, is derived from a reduction in the composite trip attribute from G^{MSL} to G^{A}. But, when the slope is positive, as shown in Fig. 7.2, a CS, ABC, is derived from an increase in the composite trip attribute from G^{MSL} to G^{A}.

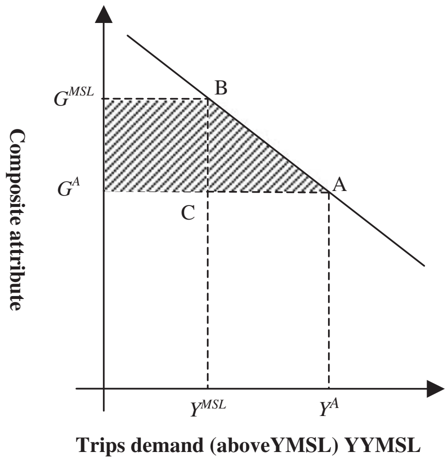


Fig. 7.1. Composite Demand Function – Negative Slope.

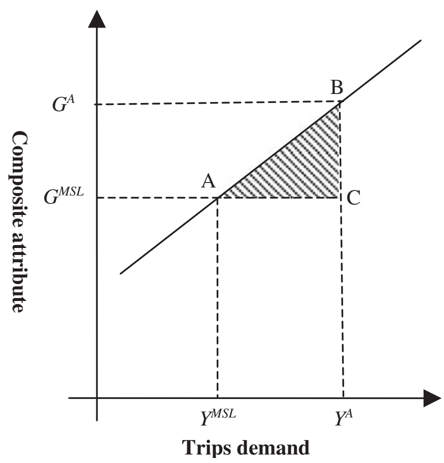


Fig. 7.2. Composite Demand Function – Positive Slope.

In both Figs. 7.1 and 7.2, CS derives from ABC, but this is supplemented by the addition of $(G^{MSL}-G^{A})(Y^{MSL})$ in Fig. 7.1. When Y^{MSL} is high and $(Y^{A}-Y^{MSL})=0$, the supplement will induce the optimization to choose a marginal difference between Y^{A} and Y^{MSL} in order to achieve a negative slope and accrue the supplement. In the programming, therefore, the supplement is accrued only when $(Y^{A-}Y^{MSL})$ is significantly different from zero.

7.3.5.2. Externality Benefit

The change in externality benefits associated with car use is defined by Eq. (7.16). We assume initially that on average every car trip switched to a bus trip reduces car use by 10 km and that 40% (20%) of all switched trips by adults (by school, children) are from car.[97] Any transfer of car trips to bus trips reduces road traffic congestion and creates an externality benefit which also contributes to SS. *EB* denotes the externality benefit generated by solution trips above Y^{MSL} and is directly comparable to *CS*.

$$\begin{aligned}
\text{EB} &= \$/(\downarrow \text{car user})(\uparrow \text{passengers from car}) \ldots \text{for each region, period}\\
&= (\$/VKM^{\text{car}})(av\ VKM^{\text{car}})(\uparrow \text{passengers from car})\\
&= (\$/VKM^{\text{car}})(10\ KM)(Y^{A}_{ACC} + Y^{A}_{S} - Y^{MSL}_{ACC} - Y^{MSL}_{S})\\
&\qquad (\text{shift factor car-bus})\\
&= (\$/VKM^{\text{car}})(10\ KM)(Y^{A}_{ACC} + Y^{A}_{S} - Y^{MSL}_{ACC} - Y^{MSL}_{S})0.4 \qquad (7.16)
\end{aligned}$$

The unit rate of externality benefit per VKM travelled by class (i) travellers, is a composite sum of six externalities, summarised in Table 7.1 for peak and off-peak and inner and outer metropolitan contexts. The evidence is drawn from the Bus Industry Confederation (2001) submission to the Commonwealth fuel tax inquiry. It is broadly consistent with the UK

Table 7.1. Marginal External Costs per Car vkm.

	Inner	Outer
Peak period		
Road damage	0.2	0.2
Congestion	90	60
Air pollution	1	0.5
Climate change	1.3	0.9
Noise	0.4	0.3
Accidents	0.8	0.8
Total	93.7	62.7
Off-peak period		
Road damage	0.2	0.2
Congestion	16	16
Air pollution	0.5	0.2
Climate change	0.9	0.6
Noise	0.3	0.1
Accidents	0.8	0.8
Total	18.7	17.7

evidence reported in Sansom et al. (2002). These unit rates do not take into account any marginal impacts associated with additional bus travel required to accommodate additional passengers. They are strictly car-related values.[98]

The patronage incentive is the sum of CS and EB (in dollars).[99] Importantly, although school children travel for free in most jurisdictions and the operators are compensated through CSO payments, additional trips by children will attract an incentive payment through increased CS, and for car switchers, through increased externality benefit. On the latter calculation we may have to impose an additional assumption as to whether the school child's bus use results in a reduction in car VKM or not, since some trips may continue.

7.4. A CASE STUDY FOR THE OUTER METROPOLITAN AREA OF SYDNEY

The formal economic optimisation framework presented in Section 7.3 has been tested on operators in the outer areas of the Sydney metropolitan area. Drawing on data collected in 2002 by the Institute of Transport Studies (ITS, 2002), in cooperation with 12 private bus operators,[100] we have extracted the relevant data for the model system. Importantly, the amount of data required from operators is relatively small and manageable for the regulatory task. Benchmark costs are those of the most cost efficient operator in the set.

Exogenous indicators, such as elasticities, unit externality cost rates, willingness to pay parameters, MSL VKM, etc., are provided from non-operator sources, and can be modified as new information becomes available. We have selected what are regarded as best-knowledge estimates in this case study to illustrate the feasibility and appeal of the analytical relationships used to establish appropriate incentive payments for PBCs under a SS maximisation subsidy scheme. In the current chapter we focus on the transition-phase of introducing PBCs and set the subsidy budget to the existing operator-specific level. In a follow-up paper, Hensher and Houghton (2005c) generalise the approach to optimise the total subsidy budget under a 'growth after transition' schema.

7.4.1. The Budget and %MSL in Scenario I

The current subsidy level for the operator is TB = $7,304,306. It is determined exogenously in part to accommodate the demographics of the region and availability of other modes. The case study operator advises that TB meets costs for %MSL of around 67% of annual route VKM.[101] Best practice total costs per kilometre ($VKM) in the Sydney bus sector for 2002 are estimated at $2.60 in peak and $2.30 in off-peak periods. However, the subsidised kilometres generate fare revenue at current rates of $0.80 per VKM in the peak and $0.65 per VKM in the off-peak. This revenue is retained by the operators and gives a net cost per kilometre of $1.80 in the peak and $1.65 in the off-peak. Using the net cost rates, the specified subsidy meets 76.9% of VKM – compared to the operator's estimate of around 67%. It is clear that the current subsidy regime will leave a surplus above the requirements for %MSL = 67%, and this is assumed to be made available as incentive payments for ($CS+EB$). This subsidy environment is defined as Scenario I, and is regarded as the base case for further scenarios presented in Hensher and Houghton (2005c).

The subsidy regime for the scenario is summarised in Table 7.2. The components of X(MSL), from (7.6), are 1,385,974 km for the peak and 2,342,948 km for the off-peak periods. Applying the net cost/km produces an MSL subsidy cost of $6,360,617. The balance of the subsidy budget, $943,689, is assumed to be made available as incentive payments for ($CS+EB$). Scenario I is, therefore, a 12.92% performance-based regime. Parameter settings to accommodate Scenario I are TB = 7,304,306, %MSL = 0.67, and $R = 0$. For later scenarios, R may be set to a percentage subsidy restructuring from MSL to PBC as compared to the base case.

The model is optimised over P, the payout rate on ($CS+EB$) above the MSL level, in order to strike a parity between the existing scheme and the 12.92%PBC scheme of Scenario I. The Scenario I solution is shown in Table 7.3, where the operator's return is −9.60%. Such a return on investment is clearly unacceptable to a commercial operator. What we have revealed in the base case analysis is that this bus business (and we suspect most urban operators in Sydney) operating under the NSW 1990 Passenger Transport

Table 7.2. Subsidy Budget and Subsidy Structure.

	Peak	Off-peak	Total
Cost per km	$2.60	$2.30	
Less fare revenue per km	$0.80	$0.65	
Net cost per km	$1.80	$1.65	
Subsidy received			7,304,306
MSL kms using %MSL = 0.67 in (6)	1,385,974	2,342,948	
$CSO (Net subsidy cost for MSL kms)	2,494,753	3,865,864	6,360,617
Subsidy available for incentive payments			943,689

Table 7.3. Scenario I Solution.

Model Soln	*X*	*q*	#Bus Used	*C*	*Y* (*ACC+S*)	*CS* (*ACC+S*)	*EB* (*ACC+S*)	*Y*(*MSL*) (*ACC+S*)	*X*(*MSL*)
P-O	1,807,144	1.44	76	2,462,627	4,083,932	3,902,421	532,368	3,781,614	1,385,974
Change	**–9.03%**	**0.00%**	**8.57%**	**–15.55%**	**0.00%**	**–7.12%**	**0.00%**	**0.00%**	**–9.03%**
OP-O	3,054,924	1.52	36	12,576,988	2,794,325	1,796,263	259,467	2,412,741	2,342,948
Change	**–9.03%**	**0.00%**	**0.00%**	**–3.61%**	**0.00%**	**–9.58%**	**0.00%**	**0.00%**	**–9.03%**
Total	4,862,069	1.51	76	15,039,615	6,878,257	5,698,684	791,835	6,194,356	3,728,922
Change	**–9.03%**	**0.10%**	**8.57%**	**–5.79%**	**0.00%**	**–7.91%**	**0.00%**	**0.00%**	**–9.03%**
TB	7,304,306								

Funding		Retn on Cost
TB	**7,304,306**	
***CS+EB* Pay**	943,689	
FARES	6,291,216	
CSO	6,360,617	
***less* op Cost**	15,039,615	
prod surp	–1,444,093	–9.60%
CS+EB	6,490,519	
SS	5,046,426	
***Less SS* cost**	7,304,306	
Net *SS*	-2,257,880	–30.91%
***TB* undist**	0	

Control params

dbus	kappa slip	*P*	max fare inc	CSO slip
0	0.00%	14.539502%	5%	0.00%
0	0.00%	14.539502%	5%	

Y (*S*)	*CS* (*S*)	*EB* (*S*)	*Y*(*MSL*) (*S*)					
2,432,928	1,655,522	225,846	2,252,828					
0.00%	**–9.03%**	**0.00%**	**0.00%**					
221,220	74,033	10,694	191,011					
0.00%	**–20.29%**	**0.00%**	**0.00%**	***CB***	***PS***	***%PS***	***SS***	***%SS***
2,654,148	1,729,555	236,540	2,443,839	6,490,519	–1,444,093	–9.60%	5,046,426	–30.91%
0.00%	**–9.57%**	**0.00%**	**0.00%**	**–7.01%**	**–783.14%**	**–825.14%**	**–29.83%**	**13.45%**

SLACKS (neg indicates infeas)		
***X* lower**	421,171	MSL
	711,976	
***X* upper**	0	#buses
	0	
Y upper	0	quality
	0	
***PI* upper**	0	TB not dist
***q* upper**	0.07	$fare
	0.08	
Spare bus	0	

Y (*ACC*)	*CS* (*ACC*)	*EB* (*ACC*)	*Y*(*MSL*) (*ACC*)
1,651,004	2,246,900	306,522	1,528,786
0.00%	**–5.66%**	**0.00%**	**0.00%**
2,573,105	1,722,229	248,773	2,221,731
0.00%	**–9.06%**	**0.00%**	**0.00%**
4,224,109	3,969,129	555,295	3,750,517
0.00%	**–7.16%**	**0.00%**	**0.00%**

BCB (*vble*)	*ESS*
195,221,636	200,268,061

1.434

475

$CSO	6,360,617	**%MS L**	0.67
TB–$CSO	943,689	**$VKM P**	1.80
		$VKM OP	1.65
Effective *P*	14.54%		
Effective *R*	12.92%		

Table 7.4. Total Return Over Route and Charter Operations.

	Current Subsidy	Cost	Revenue	RORI
Route operations	7,304,306	15,039,615	13,595,522	−9.60
Plus charter operations		879,350	3,541,554	
Total operations		15,918,966	17,137,076	7.65

Act (and revisions) is not commercially viable without support from other sources. When the route operations are supplemented by returns on charter operations, the overall rate of return is 7%, as shown in Table 7.4, where RORI denotes the rate of return on total cost importantly, it must be noted that the costs 'allocated' to the charter operations are based on marginal costs of these additional services, and so we are comparing the minimum cost assumption with fully allocated charter revenue. It is possible to improve on the −9.6% return on investment by using average costing (pro rated by VKM); however the result will still be negative. The social benefit above MSL is $(CS+EB)$ = \$6,490,519. The optimum payout rate is 14.5%, which specifies the percentage payout on $(CS+EB)$ generated above X(MSL), and indicates that the social benefit generated under the current regime, in terms of CS and externality benefit, is 6.88 times the effective incentive payments.

In summary, an extra \$6.5 million social benefit above MSL is generated by the operators in response to a PBC component of around a million dollars. Under Scenario I, this is realised by bus operators as $P(CS+EB)$ *where P* is 14.5% which translates to average PBC payments of, \$1.21 for CS and 17 cents for externality benefit per passenger trip above MSL.

7.4.2. Fleet Size under Scenario I

In this section, the operator strategy parameters are extended to include fleet expansion as well as X and q. The subsidy regime of Scenario I is maintained, where regulator parameters TB, \$CSO and P are fixed. The fleet size is the number of buses required for route services, and in the base period this is 76 buses. It does not include any capacity cushion required for maintenance, breakdowns and charter services. Increases above 76 may be implemented through the integer variable *dbus*, which introduces capital costs as earlier described. Extra buses introduced through dbus are available to both peak and off-peak periods, and the adjusted fleet size is given by (76 + *dbus*). The optimum extended strategy is shown in Table 7.5, where *dbus* is seen to be 2, increasing the fleet size to 78.

Table 7.5. Optimum Fleet Size Strategy.

Model Soln	X	q	#Bus Used	C	Y (ACC+S)	CS (ACC+S)	EB (ACC+S)	Y(MSL) (ACC+S)	X(MSL)
P-O	1,853,227	1.51	78	2,528,628	4,101,019	4,680,667	575,560	3,773,612	1,385,974
Change	–6.71%	5.00%	11.34%	–13.29%	0.42%	11.41%	8.11%	–0.21%	–9.03%
OP-O	2,879,997	1.60	34	11,775,475	2,634,320	1,035,916	198,376	2,342,328	2,342,948
Change	–14.23%	5.00%	–5.73%	–9.75%	–5.73%	–47.86%	–23.54%	–2.92%	–9.03%
Total	4,733,224	1.58	78	14,304,103	6,735,339	5,716,583	773,936	6,115,941	3,728,922
Change	–11.44%	5.10%	11.34%	–10.40%	–2.08%	–7.62%	–2.26%	–1.27%	–9.03%
TB	7,304,306								

Funding		Retn on Cost
TB	7,304,306	
CS+EB pay	943,689	
Fares	6,359,292	
CSO	6,360,617	
less op cost	14,304,103	
prod surp	–640,505	–4.48%
CS+EB	6,490,518	
SS	5,850,013	
Less SS cost	7,304,306	
Net SS	–1,454,293	–19.91%
TB undist	0	

Control params

dbus	kappa slip	P	max fare inc	CSO slip
2	0.00%	14.539502%	5%	0.00%
2	0.00%	14.539502%	5%	

Y (S)	CS (S)	EB (S)	Y(MSL) (S)
2,452,974	1,997,118	245,576	2,257,140
0.82%	9.75%	8.74%	0.19%
212,915	43,626	8,354	189,315
–3.75%	–53.03%	–21.88%	–0.89%
2,665,889	2,040,744	253,931	2,446,455
0.44%	6.70%	7.35%	0.11%

CB	PS	%PS	SS	%SS
6,490,518	–640,505	–4.48%	5,850,013	–19.91%
–7.01%	–403.00%	–438.16%	–18.65%	–26.93%

SLACKS (neg indicates infeas)		
X lower	467,254	MSL
	537,049	
X upper	1	#buses
	53	
Y upper	69	quality
	0	
PI upper	0	TB not dist
q upper	0.00	$fare
	0.00	
Spare bus	0	
	2	

Y (ACC)	CS (ACC)	EB (ACC)	Y(MSL) (ACC)
1,648,045	2,683,549	329,984	1,516,472
–0.18%	12.68%	7.65%	–0.81%
2,421,405	992,290	190,021	2,153,013
–5.90%	–47.60%	–23.62%	–3.09%
4,069,450	3,675,839	520,005	3,669,485
–3.66%	–14.02%	–6.36%	–2.16%

BCB (vble)	ESS	
193,409,655	199,259,668	1,471
		448

$CSO	6,360,617	%MSL	0.67
TB-$CSO	943,689	$VKM P	1.80
		$VKM OP	1.65
Effective P	14.54%		
Effective R	12.92%		

X	q	#Bus	C	Y (ACC+S)	PS	CB	SS	%PS	%SS	CS/(Y–YMSL) (ACC+S)	EB/(Y–YMSL) (ACC+S)
4,733,224	1.58	78	14,304,103	6,735,339	–640,505	6,490,518	5,850,013	–4.48%	–19.91%	1.34	0.18

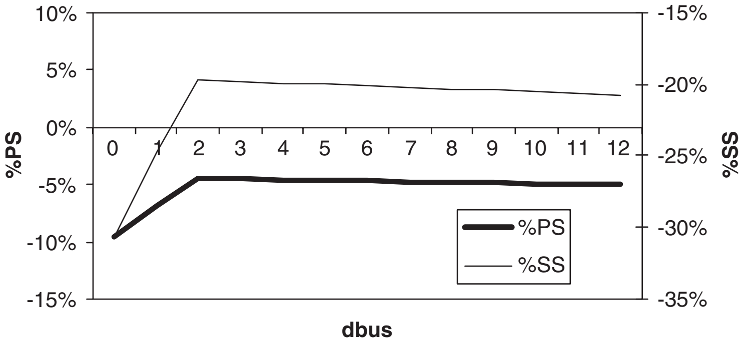


Fig. 7.3. Returns to Fleet Size under Scenario I.

Given the fixed subsidy level, incentive payments ($CS+EB$) cannot be increased above (TB-$CSO). The operator is, therefore, seen in Table 7.5 to use the extra two vehicles to increase peak services, Y^{P}, while correspondingly reducing the less remunerative service level to off-peak periods, Y^{OP}. The overall service level is decreased, but the MSL is still met, external benefits above the MSL are unchanged and, the SS is improved through the producer surplus.

SS returns on the invested subsidy TB are denoted by %SS, and operators returns on total costs by %PS. The behaviour of %SS and %PS are shown in Fig. 7.3, which demonstrates the mutually supportive property of operator and regulator optimisation that may be achieved by introducing a performance-based component to a subsidy regime. As a result, operator strategy optimisation can be expected to achieve desirable social outcomes, relieving the regulator from onerous industry control obligations in pursuit of the SS.

The returns to the regulator and the operator in the absence of a PBC component are shown in Fig. 7.4, where the PBC component is replaced by a financially equivalent addition to the MSL component. In Fig. 7.4, increasing *dbus* within a fixed subsidy regime, is seen to provide increasing social returns, but at the expense of operator returns. The absence of a PBC component allows the service level delivered to be increased without operator reward and without regard to consequent increasing operator losses. The operator and regulator are clearly in antagonistic positions. It is clear from Fig. 7.4, that no expansion would be pursued by the regulator and, what appears to be an attractive SS potential is unachievable outside a fully controlled bus industry.

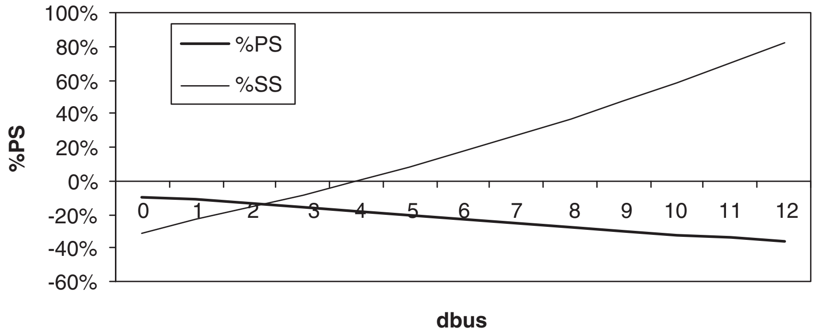


Fig. 7.4. Returns to Fleet Size under Pure MSL.

The contrast between Figs. 7.3 and 7.4 is stark and it is clear that a PBC component has introduced a level of harmony between operator and regulator, according to which the operator preference is to move in the direction of regulator preference.

7.5. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

PBCs have emerged as a practical contracting regime with many virtues. Under a transparent partnership between the regulator and the service provider, a PBC offers a most effective way of delivering transport services, ensuring over time that the allocation of subsidies is determined optimally *from a system-wide perspective*, not on an individual contract by individual contract basis (as would be required under other contracting regimes).[102]

The proposed system of subsidy which brings profit maximisation on the part of operators into harmony with SS maximisation, appears to offer a very attractive contract regime. Nash and Jansson (2002) in reviewing alternative reform schemes introduced over the last 15 years, conclude that ‘‘the regulatory phase could be better managed this time round, with an emphasis on ‘light touch’ regulation, perhaps combined with the appropriate use of subsidies per passenger kilometre and infrastructure charges to incentivise the franchisee to provide the socially optimum fares/service combination’’. This is the intent of PBCs both in transition and post-transition.

The method developed and implemented in this paper is sufficiently flexible to be applicable under a large number of regulatory and operating regimes. For example, it is feasible to consider alternative fare increase caps, different aggregate subsidy budget levels (be they increments or decrements on existing levels), variations in the balance of minimum-service levels and incentive payment rates for environmental benefits, and acceptable commercial returns. The ability to recognise the full extent of consumer (i.e., user) surplus benefits to society and to determine the amount that might reasonably be paid to operators to ensure that the returns are incentive-compatible, without delivering unacceptable high rates of return to operators from the provision of public funds, is a very appealing feature of the approach.

The model developed herein has been implemented for the benchmark (in terms of cost efficiency) operator in a setting where there is potential patronage growth. However in a transition to a full PBC structure, some operators will begin with cost structures that deviate from benchmark best practice as well as having varying degrees of patronage growth potential in their service area (including the extreme of almost no opportunity to grow patronage simply because the market is so thin). In ongoing research, Hensher and Houghton (2005c) have investigated transition settings with mixtures of cost performance and patronage growth potential.

Hensher and Houghton (2005c) also recognise that the PBC framework developed herein can be extended beyond the transition stage, to encourage growth from transition, and to establish the SS maximisation solution under an unconstrained subsidy budget. This stage of growth after transition will consolidate the fuller extent of VM under a PBC regime. The transition stage however is crucial in an environment where established operators have demonstrated (to varying degrees) the ability to deliver service quality. The transition to an incentive-compatible contract scheme should ensure greater gains to society in the future which may have been denied by the existing contract regime.[103] Future research will develop decision rules for applying the scheme in new regions.

CHAPTER 8

DELIVERING VALUE FOR MONEY TO GOVERNMENT THROUGH EFFICIENT AND EFFECTIVE PUBLIC TRANSIT SERVICE CONTINUITY: SOME THOUGHTS

8.1. INTRODUCTION

This paper documents some thoughts on the reform agenda in public transit that is occurring throughout the world. The specific focus is on the commitment to competitive regulation through competitive tendering (CT), and the interest by a few governments to control the tangible assets used by private operators as a mechanism to exercise the opportunity if so desired to put previously private sector protected services out to competitive tender. The views presented herein are in part based on knowledge of what ensued in the Metropolitan Reform process in Sydney leading to the signing of contracts in 2005 and the focus of the 2006–2007 reform programme outside of the Sydney metropolitan area; and an appreciation of the evidence from around the world presented at the International Conference Series on Competition and Ownership of Land Passenger Transport, known as the Thredbo series (see Hensher, 2005),[104] as many jurisdictions have undertaken wide ranging reform of their public transport (PT) systems, especially bus and coach. The Thredbo series provides a rich array of real world experiences as many countries test the full gamut of procurement and funding models (Macário, 2001; Norheim & Longva, 2005; Preston, 2005; Preston & van de Velde, 2002; Viegas & Macário, 2001; van de Velde, 2001; Van de Velde and Pruijmboom, 2003; Van de Velde, Hilfering, & Schipholt, 2005).

We review theoretical arguments and empirical evidence on contracting regimes and asset ownership, and the role that government and operator might play in a setting in which building trusting and collaborative partnerships, within the context of formal procurement contracts, has merit in delivering services that are in the main funded from the public purse. The focus on cost efficiency and quality (or service effectiveness), and incentives to innovate as contractible and non-contractible elements, is key to the arguments.

8.2. THE INDISPUTABLE STRATEGIC OBJECTIVE OF GOVERNMENT ON BEHALF OF SOCIETY

The broad objective(s) of government might best be summarised as follows: to provide a good quality, integrated and continually improving transit service for a fair price, with reasonable return to operators that gives VM under a regime of continuity. From an operator's point of view, there should be no argument with this, provided there is industry buy-in and confidence in the procurement and continuing funding procedures.

There are a lot of valuable signposts in this objective, focussed on securing appropriate services for the community in the context of a *trusting partnership* between all stakeholders (especially the government and the service provider), mindful of the social and commercial imperatives that each stakeholder works towards, given each parties legally sanctioned contractual obligations. There is a strong recognition from the outset that the service provider (i.e., transit business) is a crucial input, but only one input, into the overall obligations of government to provide mobility and accessibility services to the community, that are consistent with VM per taxpayer dollar.

Given the requirements to meet social obligations, there is the risk that *social obligation* gets misinterpreted as either delivering VM (a popular phrase, defined so often as doing more with less), rather than the preferred definition (globally) of *maximizing accessibility or net social benefit per dollar of government funding*.[105] The latter is useful under all contractual arrangements since government still has substantial investment in the infrastructure and demand management of the system. Underlying this focus is recognition that building an efficient and effective supply chain of stakeholders in public transit provision requires a foundation strong in trust, with its distinct commitment to cooperation and collaboration. As far as we can tell, many jurisdictions have a way to go in connecting through a trust chain.

8.3. TRUST, COOPERATION AND COLLABORATION

Trust is the expectation that arises within a community of regular, honest and cooperative behaviour, based on commonly shared norms, on the part of that community. There are two types of trust: thick and thin trust. Thick trust should be present when there is a set of complex intertwined relations covering many aspects of economic and social life. Thin trust involves more limited contractual relations; such as an exchange relationship in the market. *Cooperation* and *collaboration* are distinct levels of relationship (Golicic, Foggin, & Mentzer, 2003). Collaboration, which is a stronger magnitude than cooperation, involves decision making in an active capacity whilst sharing key information. Collaboration requires trust, integrity and reliability, which can help lead the relationship to grow stronger over time.

Repetition leads to cooperation and collaboration and the by-product is trust. The evidence can be attributed to Professor Robert Oumann, a game theorist, who was awarded the 2005 Nobel Prize in Economics. Oumann showed in his writings that repeated games, compared to a single game, leads to greater cooperation. An interpretation of this in the transit context, given the focus on efficient and effective continuity in the context of *incomplete* contracts, is the growing of partnership by building on relationships; something that is arguably relatively limiting with CT (especially short-term contracts such as 5–7 years[106]), but reinforcing through negotiated PBCs with incumbents and rules for non-compliance. Another way of viewing this is to think of it as 'ironing out the wrinkles' over time and moving forward with continuity in the delivery of efficient and effective services. Importantly, the trust building paradigm must exist within a framework that has clarity on the obligations under legal contracts; however we will argue below that it is the incompleteness of such contracts that makes for the case for combining trust and legal contracting obligations, rather than promoting one or the other.[107]

This links to the broader literature of transactions economics and costs, and property rights and the boundaries of a business, offers ideas on a range of contractual mechanisms for buying transparency, efficiency and effectiveness.

8.4. SUPPORTING EFFICIENCY AND EFFECTIVENESS THROUGH THE LIFE OF A CONTRACT (AND NOT AT THE TIME OF TENDERING)

The focus of any reform process must be on (cost) *efficiency* and (service) *effectiveness*, promoting *continuously uniform* competitive pressure through the life of a contract, with CT only one of a number of options, but an appropriate instrument for non-compliance under all regimes. In presenting the arguments, it is important to recognise that some elements of the efficiency-effectiveness dyad will be contractible, but many may be non-contractible; and it is often through the non-contractible dimension that we see innovation and benefit that is typically delivered better by private ownership than by government ownership of tangible and intangible assets.

Transaction cost economics (TCE) provides a relevant framework within which to develop the arguments for the roles of the *market* and *governance* which is so central to the reform process. A transaction occurs when one stage of activity finishes and another begins. With a well-working interface, these transfers occur smoothly. TCE supplants the usual preoccupation with technology and distribution costs, with an examination of the comparative costs of planning, adapting and monitoring task completion under alternative governance structures. It is as much about transactions within a single entity (e.g., one transit operator, a regulator) as it is between entities. It pays special attention to information signalling and processing and its asymmetry throughout the system (i.e., where the expertise really resides), bounded rationality (i.e., the ability to process a limited amount of information), hazard, opportunism and asset specificity (Williamson, 1979).

Importantly for any ongoing reform process, TCE maintains that it is *impossible* to concentrate all of the relevant bargaining action at the ex ante contracting stage (which is what CT essentially does; especially in the presence of inadequate ex post monitoring). Instead bargaining is pervasive, in which case the institutions of private ordering and the study of contracting in its entirety take on critical economic significance. PBCs, which can be negotiated under an unambiguous condition of expected performance, align with this view (Hensher & Houghton, 2004, 2005) since the market operates actively throughout the contract period, under signals delivered through incentive payments and benchmarked efficiency – or what is known as yardstick competition. The behavioural attributes of human agents, whereby conditions of bounded rationality ('doing what each party is best at' i.e., specialisation) and opportunism (e.g., 'looking for appropriate opportunities to grow patronage') are joined, and the complex attributes of transaction with special reference to the condition of asset specificity, are responsible for this condition (Williamson, 1987, p. 178). *Alignment of incentives is central to efficient contracts and property rights*. The latter emphasises that ownership matters, with rights of ownership of an asset (tangible and intangible assets) defined as the rights to use the asset, the right to appropriate returns from the asset, and the right to change the form and/or substance of an asset.

TCE acknowledges merit in both monopoly and efficient risk-bearing approaches to contracting. It insists, however, that efficiency and effectiveness purposes are sometimes served by restraints on trade (Williamson, 1987, p. 188). This statement is crucial to the discussion, because it puts forth the argument that examination of the underlying attributes of transactions discloses that restraints on trade can help to safeguard the integrity of transactions when transit operator-specific investments are at hazard, with downside consequences on service delivery.

8.5. ASSET OWNERSHIP – A KEY ISSUE LINKED TO THE BOUNDARIES OF A TRANSIT OPERATOR'S BUSINESS

The relationship between asset ownership and incentives is an important kernel of the debate in some reform processes. What we are seeing in Sydney in particular, where assets are currently owned by private transit operators[108] is a position of progressively relinquishing ownership of tangible assets (vehicles in particular) through new financial arrangements when assets are being replaced, opening up in time (potentially) to CT. If an incumbent operator is cost efficient and service quality effective, what does this do to incentives to invest and grow the business?[109] And what incentives are provided by competitively tendered management contracts, as for example in Adelaide and Perth in Australia (Hensher & Wallis, 2005), where one is starting with a 'clean slate' in the sense of no initial private incumbents?[110]

TCE (Williamson, 1985) can assist in addressing the question of what determines business boundaries. The basic tenets of the property rights framework can be usefully discussed in terms of an arrangement between a principal (i.e., the government) and an agent (i.e., the transit operator) hired to accomplish some task. As principal–agent theory has long argued, appropriate incentives must be provided for the agent. In general, because the principal cannot directly measure the effort level of the agent, incentives need to be provided by making the agent's remuneration partially contingent on benchmarked performance. An example is the incentive payment that a transit operator might receive from improved service quality. A basic conclusion of the theory is that agency problems can be mitigated, and sometimes even solved, by offering the agent a sufficient share of the output (i.e., rewards) produced, commensurate with the risks they take and an agreed margin.

However, problems arise when it is not possible to specify clear performance measures in advance (i.e., a poorly structured contract that does not build in clear performance benchmarks and agreed variations). For instance, the government may have insufficient information to pre-specify the decision-making activities of the transit operator; after all, that's presumably what they were hired to do. The solution prescribed by agency theory calls for a *comprehensive contract* that considers the marginal value of all possible activities of the transit operator and the marginal cost to the transit operator in all possible states of the world, such as innovative improvements, and the ability of government to commit to pay the appropriate compensation for each outcome (Hart & Holmstrom, 1987). Lacking such a comprehensive contract, incentives, and therefore production, will be sub-optimal.

Rich economic theory has emerged in recent years that combines the insights of TCE on the importance of bounded rationality and contracting costs with the rigour of agency theory. The theory focuses on the way different structures assign property rights to resolve the issues that arise when contracts are incomplete. This provides a basis for defining different organisational structures by the ownership and control of key assets. Grossman, Hart and Moore (GHM – Grossman & Hart, 1986; Hart & Moore, 1990) pioneered this approach, and its relationship to earlier approaches has been lucidly documented by Hart (1989).

A key tenet of the GHM approach is that, unlike the contracts typically analysed by agency theory, real world contracts are almost always 'incomplete', in the sense that There are inevitably some circumstances or contingencies that are left out of the contract, because they were either unforeseen or simply too complex and/or expensive to enumerate in sufficient detail. Shliefer (1998) broadly describes all non-contractible elements as 'quality', which in the transit case may include innovation, planning expertise, driver attitude and manners, vehicle cleanliness, etc. Incompleteness is a natural consequence of the bounded rationality of the parties.

Each of the parties will have certain rights under the contract, but its incompleteness means that there will remain some 'residual rights' that are not specified in the contract. *When these rights pertain to the use of an asset*, the institution which allocates these residual rights of control is referred to as property ownership. All rights to the asset not expressly assigned in the contract accrue to the person called the 'owner' of the asset. For example, if a bus purchase contract says nothing about its maintenance protocol, then it is the transit owner who retains the right to decide on the level of investment (which may not be optimal).

The allocation of the residual rights of control will have an important effect on the bargaining position of the parties to the contract after they have made investments in their relationship. In the absence of comprehensive contracts, property rights largely determine which ex post bargaining positions will prevail. What we are seeing in Sydney is a very explicit allocation of property rights moving towards Government. Is this likely to be a trend or has Sydney got it wrong? In particular, a party that owns at least some of the investment in the asset will be in a position to reap at least some of benefits from the relationship that were not explicitly allocated in the contract, by threatening to withhold the assets otherwise.[111] A party who does not control any assets must rely on the letter of the contract or the goodwill of the asset owner to share in the output. As a result, an agent who controls no assets risks going unpaid for all effort not explicitly described in a contract.[112] In contrast, the agent who controls assets that are essential to the relationship can 'veto' any allocation of the residual rewards not considered sufficiently favourable. Thus, the ownership of assets and the receipt of any residual income stream go hand in hand.

Ownership matters when an organisation makes specific investments (Williamson, 1975, 1985) and where contract incompleteness leads to distorted ex ante investments (Grossman & Hart, 1986). Grossman and Hart show that the agent whose ex ante investment is 'essential' to making the most productive use of an asset should own it. Hart and Moore (1990) suggest that an asset should be owned by an agent, or a coalition containing the agent, who is *indispensable* to the asset (i.e., without their participation the asset has no effect on the marginal benefit of others). They further argue that an agent who is *dispensable* should have no ownership rights over assets.

Efficient ownership would seem to depend both on where the investment is taking place and which is the indispensable party. Could there be a case for Government ownership of the physical assets if Government is either the party that undertakes all 'essential' investment (with operators therefore dispensable) or the party viewed as indispensable? Shliefer (1998, p. 137) point out that GMH theory does not model Government participation specifically, and goes on to demonstrate that Government ownership is rarely the most efficient at providing 'essential' investment in non-contractible elements. Public managers have relatively weak incentives to make 'essential' investments (particularly innovation) as they are not the owner and will receive only a fraction of the returns. Shliefer (1998, p. 138) argues that the question of ownership in the Government context is rather one of whether high-powered (market) incentives are appropriate to the procurement context.

Shliefer (1998) outlines a small subset of cases where low-powered incentives (provided by Government ownership), such as legal rules on compensation of bureaucrats, complexity of government objectives and public setting rules (which reduce the return to public managers), are more appropriate when private ownership would otherwise lead to excessive cost reduction,[113] to the detriment of non-contractible quality. Private ownership is, however, generally considered superior even where there is strong incentive to sacrifice quality for cost savings for three reasons: gains from innovation through private ownership may outweigh the negative effects of cost pressures; where there is competition (especially with the car), demand influences quality as well as costs; where there are repeat transactions the reputational effect tends to negate cost pressures. Shliefer does not consider public transit as a case requiring low-powered incentives through Government ownership. High-powered incentives embedded in PBCs, (see Hensher and Houghton, 2005a) such as patronage and service incentives can provide the incentives for an efficient outcome.

Our focus has been on physical assets (e.g., vehicles) despite the fact that 'essential', specific investment in the transit industry is more likely to involve intangible human assets (e.g., information, experience and skills). Simon (1982) has long argued for a greater emphasis on these intangible assets:

> My central theme has been that the main productive resource in an economy are programs – skills, if you prefer – that in the past have been partly frozen into the design of machines, but largely stored in the minds of men.

Given the continuing information explosion, the role of 'intellectual capital' is becoming more significant. As Drucker (1992) put it:

> In this society, knowledge is *the* primary resource for individuals and for the economy overall. Land, labor and capital – the economist's traditional factors of production – do not disappear, but they become secondary.

Hart and Moore (1990) show that control over a physical asset can lead indirectly to control over human assets, where the owner exercises their ability to exclude others from the use of that asset. The owners of the human assets are provided with incentive to act in the owner's interest in order to make use of their asset-specific, human investment. Shliefer (1998) emphasises, however, that Government ownership of any kind of asset is usually inefficient. Given the interdependence between tangible and intangible assets across the full spectrum of contractible and non-contractible activity, if you take the ownership of contractible tangible assets away from the private sector, we engender higher risks of malfunctioning (also see note 8), especially where there is a sizeable amount of non-contractible quality.

In summary, a specific asset should be owned by the organisation that can use it most productively. Importantly it is the interaction of contractibility with the need to provide incentives via asset ownership that defines the costs and benefits of market coordination. Government ownership is rarely efficient, and private ownership with appropriate performance incentives can provide the least distortion to ex ante investment incentives.

8.6. CONCLUSIONS

This paper offers some alternative perspectives on the role that government and operator might play in the future in the delivery of transit services. In particular, we are of the view that efficient and effective services can be provided under a carefully crafted regulatory framework that provides appropriate competitive pressures which does not necessarily require CT to deliver the appropriate outcomes.

This can be achieved under a strong continuing trusting partnership through negotiated performance-based partnerships that have strict rules on commercial relationships and deliverables. As part of a programme of reform to achieve these ideals, the matter of property rights and incentives form the backbone of establishing a framework capable of meeting the obligations of all parties.

It is possible to build a quality trusting partnership with well defined commercial (contracted) obligations; however, the contracting process will always be incomplete in practice, and hence there is a need to recognise that the contribution of each party in a service delivery chain requires close cooperation and collaboration. Continuity of *compliant* contracts is one important way of ensuring this.

APPENDIX 8A. ACHIEVEMENTS OF COMPETITIVE TENDERING, AGAINST THE MAJOR GOALS OF CUTTING SERVICE COSTS AND IMPROVING SERVICE QUALITY

Despite the apparent enthusiasm in some quarters for CT as a means of awarding public transport service delivery contracts, only about 25% of the inland public transport market in the European Union (EU) had been opened to regulated competition by 2003. This apparent lack of enthusiasm has led the EU to re-consider its position on award of public transport service contracts, to make greater allowance for direct award of service.

Wallis and Hensher (2005) report that the initial introduction of CT typically produced unit cost savings in the 20–50% range, depending on the efficiency of the previous monopoly supplier, but that subsequent re-tendering was generally associated with unit cost increases. Some of the reasons for such cost increases included more demanding service standards in subsequent tenders, unsustainably low initial tender prices and/or a lack of second-round bidders.[114] For example, in Norway, most contracts are procured through negotiated contracts, even though CT is possible under Norwegian law. Cost reductions in the 6–20% range were achieved in Norway, and cost-recovery rates improved. The *threat* of CT contributed to these cost savings. It is also arguable that the savings were partly a result of the Norwegian approach, whereby the purchaser and provider work closely together and in a flexible manner, with trust playing an important role.

A major issue is how to achieve the right balance between detailed specification and flexibility in tender/contract design to maximise the effectiveness of service delivery, a matter emphasised by Van de Velde et al. (2005) and Norheim and Longva (2005). The greater the emphasis on detail, the easier it is to monitor performance, but there is the risk that this reduces the opportunity for innovation by the provider. Thredbo 9 participants favoured the use of longer-term contracts for PT services, to give the provider an opportunity to innovate and earn rewards from successful innovation. The short length of contracts implemented in 2003–2004 in the Netherlands is unlikely to encourage operator innovation. A corollary of an argument for longer-term contracts is the need to develop means of adequately handling greater uncertainty and providing more flexibility, to cope with the inevitable need for change during the contractual period.

APPENDIX 8B. COMPETITIVE TENDERING – TOO MUCH FOCUS ON THIS INSTEAD OF THE BIGGER AGENDA

Increasingly throughout the world, most bids are awarded to the incumbent,[115] raising some fundamental concerns about the merits of tendering rather than the arguments associated with transparency. However, transparency can still be achieved under negotiated PBCs (Hensher & Houghton, 2004, 2005a). The evidence, however, is based on the current size and duration of contracts and it would be useful to know the numbers of bidders for each size-duration mix. If it shows that the larger contracts attract more bidders then there may be a case on this criterion for larger contracts; but this has to be weighed up against price reduction due to tendering and any losses in internal economies of scale through size. Clearly, we are talking about thresholds in size with a sensible range suggested above. Many multinationals look for sizeable margins to show an interest in investing, and we would need to establish what they would be under tendering. Multinationals have a good success rate in buying in contrast to bidding in, so this will remain an option; and under my preferred PBC framework, tendering exists where an operator defaults or fails to comply, and acquisition is always present.

The key issues should be continuous efficiency and effectiveness, and a transparent process. The focus on CT as the best way of delivering this is problematic for many reasons. The main reasons include:

1. The cost efficiency gains are usually a once-off (windfall), the first time CT is implemented (and typically linked to tendering where the incumbent is a large public operator).
2. CT per se is not special in the ability to build in incentives throughout the life of a contract that are additional to the bid price. Indeed it has elements of incentive incompatibility.
3. CT post the first round of CT might be defensible for transparency and as strategy for non-compliance; however, there are better ways of ensuring transparency that can offer greater certainty in service delivery and commitment to innovation. This is PBCs as detailed elsewhere by Hensher (e.g., Hensher & Wallis, 2005), the practical interpretation of the transactions cost framework presented above.

I would encourage careful consideration of the extent to which competitive tendering has delivered efficiency beyond the windfall gains that one typically observes in a first round tender (especially, if the incumbent is a public operator). To what extent are there efficiency gains through each subsequent tender round in each jurisdiction?

The arguments that we must tender for transparency are in my view weak and fail to recognise other mechanisms, through the life of any contractual arrangement – commercial or otherwise, to ensure efficiency and sustainability. Do we pay a high price for transparency (costs > benefits)?

Despite these concerns, CT is still popular in some jurisdictions. There are clear once-off financial gains from public monopoly, and we usually observe increased vehicle kilometres (VKM) but no signs of passenger kilometres (PKM) growth. The Dutch experience is most recent. The crucial matter is to establish competitive pressures (which are efficiency and effectiveness linked). The questions to be answered relate to when might the competitive pressures be applied – (i) at procurement? (ii) during the life of the contract? or (iii) over both time settings?

I recommend that there is a more careful consideration of the real net benefits of periodic contestability in particular. The developments in recent years in PBCs should be taken more seriously. This includes *negotiated contracts* but clarification of what a negotiated contract is seems crucial for fear that it is misunderstood as a deal between operator and regulator. It is not simply working out a deal with an incumbent with no competitive strings attached. It must be (i) performance-based, (ii) incentive compatible, (iii) involve sharing risk and reward and (iv) it must ensure competitive pressures throughout the contract (focussed on efficiency and effectiveness). There must be recognition of adaptation (i.e., variations as circumstances change).

Finally, benchmarking is essential to ensure that government funds are consistent with value for money on a series of efficiency and effectiveness partial ratios that correlate with the global measure of *maximising accessibility or net social benefit per dollar of government funding.* Roll-over contracts should be a reward for effort (strong innovation incentive via longer contracts).

APPENDIX 8C. EFFICIENT DELIVERY OF PUBLIC FUNDS

(i) Contract Duration

The establishment of the design of contracts, the competitive environment in which they are procured and the associated administration costs to the regulator (and the operator's) is central to the technical tasks of securing efficient and effective services. Hensher and Houghton (2005a) have reviewed these matters in detail and summarised the main findings from a workshop at Thredbo 8 devoted to this theme. The comments below reflect, in part, the international evidence and experience.

The issue of contract duration is clearly important but one needs to be reminded that 'one size does not fit all'. For example, *flexibility in contract* term can also assist in accommodating operator development. For example, a range of options exists between contracts in Perth, Western Australia, with a life of up to 14 years including a renewal period, and the negotiated contracts in Toronto, which apply over 6 months; and the width of this range highlights the potential benefits of developing trusting T–O partnerships. Five to seven years appears to be the range for the majority of contracts, but there can be circumstances where the investment requirements would support a longer-term contract, and as suggested elsewhere in this paper, short contract periods (even 7 years) create problems with investment into the industry.

All of this however is premised on the assumption that the operator owns the assets. If we are considering a model like Adelaide where the operator essentially has a management contract, then this could change; however contracts recently signed in Adelaide are for 10 years. It seems that 10-year contracts provide a greater incentive to invest in developing the business. However, I would also argue that a negotiated PBC not only provides the necessary incentives to invest, it also keeps operators motivated (given life-long competitive pressures linked to auditing, benchmarking, etc.) to grow the business, make it more efficient and to minimise the transaction costs associated with operator turnover. If there is little turnover anyway, as evidenced in growing number of jurisdictions, why tender; but importantly ensure an incumbent delivers under competitive pressure.

(ii) Contract Size

Contract size is a little explored theme but one with lots of opinions. The preference for larger contracts by government agencies (like the outcome in Sydney – from over 30 contracts down to 15) is the result of a belief that network services (or cross-regional corridor services) can be facilitated more efficiently. The jury is still out in Sydney, for example, since there is no evidence that the market for longer distance transit public transport trips actually exists except to the CBD of Sydney, which is already well served by such cross-contract area services (given that the CBD is a contract-free zone).

Is there such a thing as an optimal contract area size in a geographical sense? What criteria might one apply to decide on this? Presumably, the answer relates to demand-side considerations such as network connectivity impacts (economies of scope through networks, integrated fares, etc.) and the supply-side in terms of cost and service delivery efficiencies. It is not dissimilar to the arguments on the optimal number of firms in an industry.

There are two issues (at least) to address – what likely changes in network service delivery are desired and can be achieved by amalgamating contract areas, that cannot be achieved by alternative strategies such as establishing network alliances (even incentive-based ones) within the existing contract area regime; and will such amalgamations lose the internal (to an operator) efficiencies that currently exist and which promote sufficient observations for benchmarking performance? How many contract areas are appropriate? Preston and van de Velde (2002) comment that the U-shaped subsidy profile detected over time in CT is in part due to the winner's curse, and in part due to excessive concentration or collusion. The upping of prices in re-bids is becoming common (as observed in Europe in particular) as the number of bidders drops (as a result of fewer operators in the market). Contract area size is a feature of the literature on spatial monopoly where each contract area may be in the hands of a few operators who are able to collude activities across contract areas under their control. By amalgamating contract areas this is tantamount to the same implications for efficiency (albeit legally) as collusion.

I concluded in Hensher (2003a) that

> The arguments herein caution the support for too small a number of large contract areas on grounds of internal efficiency losses and limited gains in network economies (but support amalgamating very small contract areas). The existing empirical evidence, limited as it is, tends to support contract areas (and depots) currently serviced by fleet sizes in the range 30–100 regardless of urban development profile.

In determining the appropriate size of contract areas it is important to recognise both internal efficiency and external benefit arguments. Internal efficiency arguments recognise the importance of the performance of the service delivery entity regardless of whether the objective is commercial or social obligation. Efficiency encompasses cost efficiency, cost effectiveness and service effectiveness. External benefit focuses primarily on accessibility and in particular the integrity of the network and associated network economies. Hensher (2003a) concluded that:

> The arguments and evidence presented herein suggest that the perceived gains from the reduction in the number of contract areas are likely to be illusory. If the gains in network economies are not sufficiently large to outweigh any likely loss of internal efficiency there is no case for amalgamating contract areas … Given the major focus on local service provision, opportunities to deliver appropriate cross-regional and cross-network services can be revealed and promoted by partnerships between transit operators and the regulator.

The argument that larger contracts would have the potential to increase competition is certainly true in attracting big international players, but we need to put this in perspective. In particular we should be referring to contracts of 50 or more vehicles and not the very small ones where we sometimes see 5–20 vehicles. From what I have observed, international operators are interested if the number of vehicles is 50 plus, and commonly over 100 vehicles.

(iii) Net vs. Gross Contracts

Many new contracts are net contracts, with the variable component of costs being paid out after shadow fares are calculated, based on forecasts of patronage over an agreed period. The opportunity to have a revenue sharing component for revenue in excess of an agreed amount is an appealing incentive but may be rather blunt if the patronage opportunities are limited. We have to recognise that an element of patronage growth is a result of population growth and nothing to do with improved services. One should, on equity grounds at least, consider this since it seems unfair if an operator invests in improved services that create patronage growth and their rewards are similar to those operators who rely on population growth alone.

The use of shadow fares, as for example, in Sydney, obviates the concern about integrated ticketing in the presence of net contracts. However, one has to have confidence in the patronage forecasts upon which are based passenger revenues initially, and this is less risky where the market is stable (and moving only as a function of population growth). One would have to settle the estimates down and agree to them in advance and only allow revenue gains through patronage growth linked to the efforts of the operator to grow the business.

In the late 1990s, London contracts were returned to gross contracts. The move to gross cost contract was an interim measure to halt the award of net cost contracts while incentivised contracts were developed. Performance did not improve. In fact it got worse as excess waiting times increased. Although the contracts took account of general inflation, the rising costs of staff and fuel were not adequately covered and consequently, operators found themselves with loss-making contracts, which in turn pushed up the cost of newly tendered contracts sizeably. Rising staff costs had led to a reduction in the salary of drivers, which resulted in a higher turnover of staff and acute shortages. Operators found themselves with fewer levers with which to control their performance and declining returns or even losses and London Transport found itself in the unenviable position of having to run a service itself when an operator, Harris Bus, went into administration and no other credible operator was prepared to take the risk and operate the route itself.

(iv) Tender Prices

The number of active bids per contract does tend to ensure a lower bid price; however, this price is increasing over time for many reasons. Benchmarking can assist greatly in establishing an acceptable ‘competitive’ contract price even in the presence of a negotiated PBC. I would seriously consider using

PBCs with benchmarking even where there is only one tenderer or at least where the incumbent repetitively wins. The fact that incumbents win in most cases says something about the gains beyond the limited windfall gains the first time the services were tendered.

(v) Contract Administration and Complexity

The cost to government of administrating the contract process is often highlighted as a reason for review and reform, and especially for having one system with larger contracts possibly of longer duration. This has been a most controversial element of the Sydney contract review and what we now have is a complex incomplete contract (over 700 pages) in which the compliancy costs to operators in particular have been substantial. While this short-run impost should settle down, and most of the detail can essentially be 'filed away', the transition costs have been huge and way beyond what was expected by all parties. Indeed the Ministry of Transport was stretched given its resourcing and intellectual capability. Consultants were primarily responsible for the design of the reform process.

While there is merit in simplification in contrast to complexity, there has to be a recognition that we are dealing with an increasingly sophisticated market that will require better services if public transport is to have a more efficient and sustainable future. The days of the family operator appear to be fast dissipating and serious family transit businesses are now appointing professionals to either run or assist their businesses. The extent to which the operator needs the expertise centres very much on what is positioned within the T- (tactical) level and what is in O- (operational) level of the strategic tactical operations (STO) framework. Options should be documented here and especially the location of service design and planning at various spatial levels, right up to the systemwide network.

Whatever the final procurement framework that emerges, it is important that the contracts or rules of registration are transparent and that the transition period is carefully thought through in a partnership with the operators and their association. One criticism of the Sydney reform process to date is the lack of transparency at various stages and the limited involvement of those who will be most affected – the operators.

(vi) Planning and Coordination

The seeming restrictions that exist in service changes, both to existing and new networks, and the ability to provide a more integrated service network, complete with one easily understood fare system and information system, is often attributed to the contractual arrangements between operators and government.

However, one has to be very careful in attributing cause and effect, since the procurement process may not be the chief cause. Rather it may be found in a failure of detailed design of the service delivery process. The government should retain the right at the strategic level to impose a set of specifications (or at least guidelines) on what types of services should be provided. It appears that many of the current frameworks do not serve the social obligation agenda very well and should be reviewed.

Information flows are crucial where a system has strong interdependencies and the provision of data to monitor the performance of entire system is essential, otherwise there is clear disconnect in establishing compliance with efficiency and sustainability. As I see it, the broad strategic level objectives of government do require determination of the performance of the *entire system* and not just that part that is directly funded by government through contracting. Hence, if there is a case for the existence of strong positive economies of network interdependencies (and supply-side economies of scale linked strongly to shared costs) where elements of services impact on each other and on the system as a whole, then the case for a procurement strategy that delivers information required for planning and policy is defensible. Any agreement to provide patronage data is appreciated but is not sufficient. After all government desires to work to develop infrastructure opportunities for them as part of its overall social obligations. Doing this with limited information (knowing it is available) is not what a partnership is all about. There has to be a way of obtaining commercial-in-confidence data that are not available to competitors.

(vii) Service Quality

There is no argument on the importance of service quality, but it is important to identify what matters to existing and potential customers influence their choice of mode as distinct from what is nice to have (increases satisfaction), but does not result in modal switching or the amount of use of a specific mode.

The inclusion of service effectiveness in addition to cost efficiency and effectiveness, in the measurement of performance is essential. The research by Hensher (see Hensher, Stopher, & Bullock, 2003) on a new way of capturing the role of a range of influences on customers satisfaction with transit services, has received worldwide recognition as a preferred way of identifying service quality impacts. Essentially, we need a way to systematically monitor the influence that specific attributes have on a user's (and ideally non-user's) perception of levels of quality service. Individuals when choosing a specific form of transport are buying a package of attributes. Thus, to quantify the contribution of each attribute in revealing the users level of satisfaction overall, we have to account for the interdependency between the attributes in the service package.

The method is detailed in Hensher et al. (2003), but what it does is provide a service quality index (SQI) for each operator, together with information on the contribution of each attribute – fares, travel time, wait time, seating, cleanliness, attitude of driver, reliability of vehicle, safety at bus stop, weather protection at bus stop, etc. These SQIs are relative across each operator in the system and so one can benchmark overall performance and/or on specific attributes. This can also be mapped into the cost efficiency space to identify the cost of delivering a specific level of service quality. The data are not hard to collect but must be collected from a sample of users, since they are truly the only meaningful source of data on service quality. Indicators such as on time running should be assessed in the context of the role of on time running through an SQI and not seen as is so often the dominant or only measure of service quality.

CHAPTER 9

MELBOURNE'S PUBLIC TRANSPORT FRANCHISING: LESSONS FOR PPPS

9.1. SCOPE

The last two decades has seen a number of major changes in the way public transport services are delivered. Whereas public monopolies long dominated service provision, with the roles of the regulator and service deliverer closely entwined, it is increasingly common to see the service delivery task passed to the private sector. This process is usually driven by expectations of (1) lower costs to government from more efficient service delivery by the private sector and (2) better service delivery outcomes from a service provider more attuned to meeting customer needs. The public sector purchases operations and/or infrastructure services, instead of delivering them itself, with the private sector taking on various risks associated with service provision and being rewarded in some way for so doing.

Great Britain led this process with its de-regulation of bus services outside of London in the mid 1980s. Complete de-regulation is unusual, the most common change being to see public sector service provision replaced by private provision by a single operator, who receives a franchise or concession to deliver services in a specified area (or route) for a specified period, usually with nominated service standards to be achieved. CT processes are commonly used to select the successful operator.

With the regulator focussing on outcomes while retaining control of key elements like minimum service standards (specified in contracts), fare levels and with performance monitoring and delivery being undertaken by the private operator, the process can be seen as a form of public private partnership, even though the emphasis is typically on operations rather than on infrastructure (although infrastructure improvement, including rolling stock, may be part of the contracting requirements).

This chapter presents the views of two individuals who believe that opening public transport markets to greater competition is not the *only* path to delivering the two major intended outcomes of lower cost service provision and higher service quality through a public/private partnership. This view has been strongly reinforced by experience in Victoria, where a notable failure of a public transport franchisee has recently occurred.

The chapter begins with a review of the recent franchising of train and tram services in Victoria, concluding that this has fallen well short of the expectations of those who drove the process. It then asks what lessons can be learnt from this failure and suggests areas in which efforts need to be focussed to reduce the risks of repeat performances.

9.2. TRAIN AND TRAM FRANCHISING IN VICTORIA, AUSTRALIA

9.2.1. Context

Melbourne, a city of about 3.5 million people, was the first, and remains the only, Australian city to franchise both its passenger train and tram networks. The tram network is one of the most extensive in the world, comprising 240 km of double track, about 80% of which operates on road space shared with motor traffic. There were about 526 vehicles in the fleet at the time of privatisation. The suburban rail network had 336 km of route length, 197 stations and about 150 train sets at that time. Both the tram and train fleets were generally acknowledged as being in need of a significant upgrade at the time of franchising. Franchising also included the regional public transport system (V/Line passenger) then operated by the State. This included rail services operated on over 4,500 km of track and some coach services. The current paper focuses on the metropolitan services, not on V/Line.

The franchise process was ‘competition for the market’ and five businesses were offered: two metropolitan train services, two metropolitan tram services and one regional train/bus service. These five businesses grew out of the State-owned Public Transport Commission and they had been corporatised as separate entities prior to sale.

The franchising occurred in August 1999 and was expected to lead to:

- substantial reductions in government subsidies (forecast to fall by about \$160 million annually in real terms over a 15 year period, on average);[116]
- significant upgrading of rolling stock; and

- service improvements (driven by incentive components in the franchisees' remuneration packages).

Large patronage increases were also expected from franchising, with a patronage growth rate of 3.6% p.a. forecast for the 1999–2014 period, or 71% increase in total patronage (compared to 1.0% average annual increase achieved over the 1991–1999 period). This major increase in expected patronage growth rates was critical in the expected funding outcome, considered below.

9.2.2. Objectives

Reducing the public transport call on the public purse was a primary motive for franchising, which was part of a much wider push by the Victorian (and other Australian Governments) at the time to introduce increased competition into the supply of goods and services that had previously been publicly provided (e.g., telecommunications, gas and electricity).

More generally, however, the then State Government set itself five goals when it began the franchising process:

1. to secure a progressive improvement in the quality of services available to public transport users in the State;
2. to secure a substantial and sustained increase in the number of passengers using the system;
3. to minimise long-term costs of public transport to the taxpayer;
4. to transfer risk to the private sector; and
5. to ensure that the highest safety standards were achieved.

These objectives mirror a balance between financial and service delivery outcomes. Sitting behind the service delivery outcome objectives was a belief that a shift in modal usage away from the private car and towards public transport was desirable, because of the unpriced external costs of car use.

The officials and consultants driving the franchising process tried to balance four objectives through the process:

- protecting system aspects that users valued highly, such as service levels, fare levels and multi-modal ticketing;
- encouraging innovation in service delivery and in responding to the marketplace;
- providing a degree of certainty to bidders; and

- providing incentives to drive service quality improvements and patronage growth.

Final criteria used to evaluate bids were:

- NPV of cash flows required from the State over the franchise period;
- quality and thoroughness of the business plan, as a demonstration of the bidder's ability to operate and manage the business in order to achieve the State's objectives;
- conformity of the transaction documents to the State's expectations;
- extent of risk transfer to the State;
- any conditions attached to the bid; and
- relevant experience.

It is noteworthy that these criteria suggest something of a shift in emphasis away from a balance between service outcomes and financial consequences and more towards financial consequences and commercial criteria as the key objectives of reform. This is probably a consequence of the reform process being centred in a Transport Reform Unit, established within the State Treasury, to manage the franchising process. It may also have been an unavoidable part of the process of moving from statements of intent to details of contract delivery. Service delivery aspects were essentially handled by the inclusion of an Operational Performance Regime in the franchisee remuneration package. A patronage incentive component was also used as a way to reward passenger growth.

9.2.3. Remuneration Components

Franchisees receive three major fixed payment flows from the State:

- a base operating subsidy for provision of specified levels of services;
- rolling stock payments relating to lease costs for the purchase of new rolling stock; and
- capital grants for the construction of infrastructure and rolling stock capital projects.

These fixed base operating subsidies were expected to reduce to zero by 2010 (Fig. 9.1).[117]

Franchisees also receive variable payments for:

- concession fares (topping up revenue from 50 to 75% of full fare for a concession passenger);

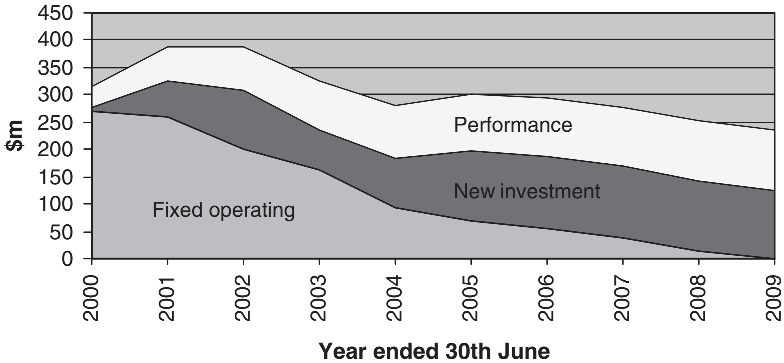


Fig. 9.1. Expected Periodic Payments to Melbourne.

- a patronage growth incentive, equivalent to 50% of the real growth in fare revenue above a threshold, where that threshold reflected revenue gains that were thought to be easily achievable (by reducing fare evasion); and
- operational performance bonuses/penalties for service reliability and punctuality.

From these various fixed and variable payments, franchisees need to pay the State for leases of infrastructure owned by the State, such as track, stations and tram stops, together with lease payments for commercial sites (e.g., depots).

Performance payments were projected by franchisees to grow from 12% of total payments in 1999/2000 to almost half the total payments by 2009, by which time operating subsidies were expected to be zero. By 2014, almost all payments were expected to be performance or investment based. Fig. 9.1 (derived from Russell, 2000, Fig. 9.2, p. 149) shows the major expected revenue flows, as seen at the start of the franchise period.

9.2.4. *Expected Outcomes from Franchising*

In summary, the franchising process was expected to lead to:

1. a progressive improvement in service quality available to public transport users
   - service delays reduced by about 40% over 10 years
   - a planned 11% increase in services over 10 years
   - $1.5 billion investment by the private sector in new/upgraded rolling stock
   - $0.8 billion to renew existing infrastructure

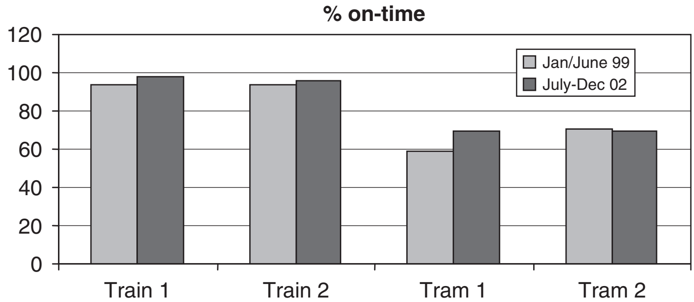


Fig. 9.2. On-Time Performance of Melbourne's Trains and Trams.

2. a substantial and sustained increase in PT patronage
   - 71% over 15 years
3. much reduced long-term costs of PT for the taxpayer
   - savings of over $1.8 billion in real terms over 15 years, or about $160 million annually
4. risk transfer to the private sector
   - franchisees to assume revenue, operating and legal risk, except in limited circumstances
   - by 2009, performance-based payments to constitute almost half total payments to franchisees
5. ensuring the highest safety standards are maintained
   - operator accreditation required from the Public Transport Safety Directorate
   - all franchisees reputable international operators.

9.3. ANTECEDENTS

Before reviewing the early outcomes of the franchising process, it is instructive to understand the context against which that process occurred. Prior to franchising, the Victorian Auditor General reported that on-going annual savings of at least $245 million had been delivered by a transport reform programme implemented earlier in the 1990s in provision of train and tram services, against a cash appropriation of $565 million in 1991/1992.[118] The major part of these savings resulted from labour shedding, with numbers falling from 18,000 by about 9,600 between 1992 and 1997. In 1998–1999, the State cash cost of providing passenger rail services was $450 million, with the true economic cost assessed at about $850 million.

The Auditor General noted that sustaining these financial benefits through a franchising process would require:[119]

> … that effective action is taken in two key areas, namely, successful implementation of the automatic ticketing system and development of a strategy to control and accurately monitor fare evasion within the automated ticketing environment.

The Auditor General concluded that the 1990s transport reform programme, in addition to reducing the call of public transport on the Victorian taxpayer, had:

- improved service reliability, with the notable exception of the peak period reliability of the suburban train fleet, with its aged rolling stock;
- improved punctuality, but that more needed to be done to achieve world class standards;
- reversed declining patronage trends; and
- improved service availability (e.g., a 23% increase in train suburban kilometres between 1991–1992 and 1996–1997).

In short, reforms were on the right track before the franchising process began, in terms of governmental objectives, and had already delivered substantial gains, especially in the financial area.

Interestingly, the Auditor General also noted that:[120]

> After 6 years of cost-cutting and rationalisation of operations, there appears to be limited scope for further large savings to be achieved in an environment where a substantial proportion of existing rolling stock will need replacement over the next few years.

This judgement did not deter the privatisers from seeking further substantial economies!

The Auditor General confirmed the need for the approaching franchised system to contain contractual requirements that included suitably stringent performance standards and incentives and penalties for operators to increase patronage and improve services.

9.4. OUTCOMES FROM FRANCHISING

9.4.1. The High Profile Outcome

It is now over three years into the franchise process, time enough to form a view on its early achievements.

The most publicised outcome of the franchise process has been the financial failure of the National Express Group (NEX), the largest operator among the new franchisees. NEX won the right to provide one of the two metropolitan train services, one of the two metropolitan tram services and the regional passenger service. NEX ceased operations in late 2002, only three years into the franchise process. Outstanding creditors are owed at least $70 million, with a likelihood of receiving about 40 cents in the dollar, or less. NEX has forfeited its performance bond of $135 million, which the State Government has indicated it is using to help meet the increased costs of future replacement services. At the same time, the contractual arrangements with the remaining two franchise operators are shifting more towards *management contracts* and away from the strongly incentive-based arrangements that characterised the initial deal.

At a more detailed level, the Victorian Department of Infrastructure (DOI) and the Victorian State Budget report various Key Performance Indicators of the Melbourne public transport system. These enable some comments about emerging patterns in performance, compared to the outcomes that were expected from the franchise process (as outlined above).

9.4.2. Financial Outcomes to the State

State payments to franchisees totalled $301 million in (part of) 1999/2000, about $30–40 million less than had been forecast for that year (in current prices) and $349 million in 2000/2001, about $75 million less than had been forecast for that year (in current prices). This latter shortfall was mainly due to capital grants about $30 million less than expected and the base plus incentive payments being each about $18 million short of expectations. The shortcoming in the capital grants area is probably a reflection of the financial troubles being experienced by franchisees at this early stage, troubles senior officials in the franchise companies were prepared to admit in private.

The 2001/2002 payment figures were broadly in line with the expected figure for that year, although incentive payments as an individual component were only about half the expected number, particularly due to shortfalls in the patronage incentive. Patronage numbers were not growing as quickly as required or forecast.

Within total payments to franchisees over the 2000–2002 years inclusive, the franchises operated by NEX received over 60% of total franchisee payments from the State, these NEX payments averaging about $240–250 million annually. Nonetheless, NEX was unable to continue its operations.

Press comment at the time the franchise was handed back suggested National Express was facing a write-off of over $300 million on its Victorian franchise investments.[121]

The failure of one of the franchisees was not unexpected. In February, 2002, the State Government committed an additional $105 million to the franchisees, with $68 m. payable in the short term. This was widely interpreted at the time as a bail-out, although part of the payments were described as 'settling outstanding contractual disputes from the time of franchising'.

The Victorian State Budget for 2003/2004 continued the process of upping the financial commitment to the franchised services. The Budget Papers suggest that an additional $1 billion over the next five years will be needed to sustain these public transport services, increasing the cost of the franchises from $1.75 billion to $2.75 billion over that period. This is an increase of well over 50% for the period in question.

Problems with the introduction of the automatic ticketing system and with levels of fare evasion (argued to cost about $50 million annually in terms of foregone revenue) have contributed to all franchisees' financial problems, as the Auditor General had previously warned. For example, almost 30% of ticketing machines on the train system were out-of-service early in the franchise period (run under a separate contract to the franchise contracts). Also, fares increased by 14% in six months, following the introduction of a new Commonwealth Government Goods and Services Tax (at 10%) and fare indexation. This fare increase and the associated problems with the ticketing system are thought to have led to increased fare evasion, contributing to a fall in real total system fare revenue available to operators in 2000–2001, even though revenue had increased 11% in the first year after franchising. This real revenue reduction was a blow to the franchisees.

While recognising ticketing and fare evasion problems, there is little doubt that over-optimistic bidding was a fundamental problem in the National Express failure, with cost savings being harder to deliver than anticipated and significant patronage gains being hard to realise. The *Australian Financial Review* expressed it this way (AFR, 18th December 2002, p. 54):

> … the bidders were responsible for a large share of their problems. They were supremely arrogant in their belief that they could replicate the patronage increases and cost savings achieved in Britain, and made commitments they couldn't keep …

The additional $200 million required annually from the State Government compares quite closely with the $160 million or so annual savings projected through the lives of the franchises, once allowance is made for inflation. Thus, while the franchising process seems to have delivered financial savings in the three years to date, largely courtesy of the shareholders of the franchisees, it seems highly likely that these savings are unsustainable and that Victorian taxpayers will see no long-term financial savings from the franchising process. Most of the financial gains were delivered prior to franchising and the Auditor General seems to have got it right when he predicted in 1998 that further financial savings would be hard to deliver.

One irony of this financial outcome is that the Victorian State Government has recently changed its mind in favour of imposing tolls on a proposed $1.8 billion new freeway project, citing the public transport funding shortfall as a major reason for this policy change. The public transport sector will push for this pricing switch on tolling to be generalised towards a more comprehensive programme of reform in land transport pricing.

9.4.3. *Service Quality*

Improvements in service quality were a central rationale for the franchising process. What has been achieved? A small number of service quality indicators are measured and reported by the Victorian Department of Infrastructure, enabling some conclusions on trends in these areas to be drawn.

Fig. 9.2 shows that there have been improvements in on-time running, with three of the four metropolitan train/tram franchises showing improved performance.[122] Traffic congestion on shared rights-of-way is posing major concerns for the tram franchisee whose performance deteriorated. The franchising target was for 40% reduction in service delays within ten years. The on-time running data suggests that three of the four businesses are on track, or better, in this regard.

Data for the first quarter of 2003 (later than that shown in Fig. 9.2), shows that since the demise of NEX and the taking back of these services by the State Government, the on-time running performance of the train and tram businesses the group had operated has deteriorated. This confirms the suggestion from Fig. 9.2 that franchising has helped to improve service punctuality.

Fig. 9.3 shows service cancellations on metropolitan train and tram services, as an indicator of reliability.[123] These show a similar pattern to the on-time running results, with the two train services and one tram service showing improvement but the other tram service marking time.

As with on-time running, data for the first quarter of 2003 shows that service cancellations on the prior NEX services have increased since these services were taken back by the State Government, reinforcing the conclusion that franchising tended to improve service quality.

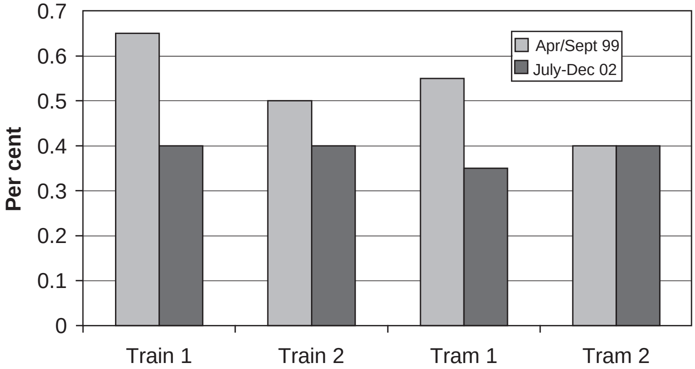


Fig. 9.3. Cancellations of Melbourne Trains and Tram Services as Per cent of Services Scheduled.

9.4.4. New Vehicles

A major objective of the franchising process was to see rolling stock upgraded, because of the expected impact this would have on patronage. To date, 36 new Citidas trams have been brought into service and 59 new Combino trams will have been delivered by December 2004. In addition, over 300 trams will have been refurbished by December 2003. The upgrading of the tram fleet is probably the most visible outcome of the privatisation process, representing a significant lift in quality. Upgrading the train fleet has been slower.

Overall, the rolling stock upgrade programme appears to have been delivered on-time and on-budget, with few operational performance problems. It is likely that the new vehicles would not be there if there had not been the prospect of substantial cost savings from franchising. The sustainability of the upgrade programme, under higher cost structures, becomes more problematic.

9.4.5. Increases in Services

Over the three years from 1999/2000 to 2002/2003, total kilometres operated by trains and trams on the Melbourne network increased by almost 5%, most of this increase in kilometres being on the train system (+1.3 mvkms, or +8.4%, in a total increase of 1.8 mvkms). This was a lower rate of overall increase than over the period immediately prior to franchising (see

'Antecedents' section above) but is in line with the expectation that services would increase by about 11% over 10 years.

Service frequency and coverage and speed/reliability are generally agreed to be the major drivers of growth in public transport patronage in Melbourne. It is difficult to see how the franchisees could ever meet their patronage forecasts with only very modest targets for growth in services. In short, franchising has met its expectation in terms of early growth in services but this expectation seems far too low to be consistent with achieving the patronage growth forecast.

9.4.6. Patronage

Patronage increases have been achieved. Total patronage on the metropolitan train and tram system was 257.3 million passengers in 2000/2001, increasing to 270.9 million in 2002/2003, an increase of 5.3% over two years. This is a good result, by comparison with the recent past, but is about 1% per annum less than was expected from the franchise bids. This shortfall is not unexpected in terms of the modest growth in service kilometres.

Tram patronage increased by 6.2%, faster than the rate of growth in train patronage of 4.4% over this period. With the growth in train service kilometres being much faster than that in tram kilometres, the likelihood is that improvements in the tram fleet have driven increases in tram patronage.

9.4.7. Risk Transfer

The financial changes that have occurred over the past 18 months suggest that not a great deal of lasting risk transfer from the public to the private sector has been achieved!!! Additional payments have been made to franchisees and one franchisee has failed financially. This will result in a need to increase payments from government to sustain services. The major expected recipients of the increased payments are the surviving train and tram operators, who are likely to see their franchises expanded in spatial coverage and shortened in time span. A more appropriate risk management philosophy is emerging. Rather than simply seeking to transfer risk from the public to the private sector, as in the initial franchise process, the new contracts will seek to assign risk to the party most able to manage it. This reflects a trend towards more of a partnership relationship.

9.4.8. Safety Outcomes

Improvements in safety were one of the objectives of the franchising process. There is no published data available to suggest whether or not this has been achieved and anecdotal evidence is mixed. Some franchisees have achieved significant improvements but this experience is apparently not the rule. Conclusion = no conclusion at present!

9.4.9. Customer Satisfaction

Regular measurement and reporting of customer satisfaction has existed for many years on the Victorian public transport services. These surveys show no significant trends over the period of franchising. Satisfaction levels rose for one tram operator around the time new vehicles were introduced into its fleet but have drifted back since, to be marginally above levels at the start of the franchise. Satisfaction with the other tram franchise has fluctuated around the starting level. Satisfaction with the two train operators has shown similar patterns. In short, customers are reporting no significant shift in satisfaction levels either up or down.

Market research conducted for the private operators suggests that dissatisfaction with the ticketing system and concerns about perceived security around rail stations may be the main reasons why customer satisfaction levels are not rising, even though there is hard evidence of improvements in some aspects of service quality. Marketing efforts are seeking to communicate these improvements to customers and deal with perceived concerns.

9.5. OVERVIEW

This review of the recent public transport franchising experience in Victoria indicates that the objective of reducing the call on the public purse has not been met and was, in reality, never likely to be met. Significant cost savings were achieved prior to franchising, when large reductions in the public transport workforce were achieved, and delivering further large cost savings was always going to be difficult in the extreme, as the Auditor General predicted.

Franchising has seen an improvement in the quality of tram rollingstock, in particular, and improvements in a number of service quality indicators, such as on-time running. However, growth in service kilometres has been slower than in the period prior to franchising. Patronage increases have accelerated compared to the period prior to franchising but by less than the franchisees' forecast. Risk transfer to the private sector has not been anywhere near as much as intended. Customer satisfaction levels are not showing any marked recognition of franchising having been beneficial to users.

Overall, this form of CT has not delivered many of the forecast benefits for Victorians.

9.6. WHY HAS THE PROCESS FAILED TO DELIVER?

9.6.1. Operator Motivations and Governmental Reform Ideology

A seasoned transport planner looking at the franchisees' forecasts of patronage growth and growth in service kilometres would almost certainly conclude they simply did not add up. Going further, when the period of cost-cutting that was undertaken during the 1990s is recognised, one must wonder where franchisees expected to achieve major additional cost savings. This leads to two key questions.

1. What were the franchisees' motivations? Did they think they could achieve cost levels well below what had hitherto been possible? Perhaps their international networks might open up economies of scope and scale that were not available locally. This seems unlikely and the State Auditor General did not expect to see major new cost reductions, as indicated previously.

Were they engaged in buying market share, with a view to subsequent upwards contract price adjustments? Quite possibly. We call this playing 'capture the regulator', a phenomenon commented on by other observers of franchising processes, such as Alexandersson and Hulten (2003) in their analysis of competitive tenders in Swedish public transport. The argument goes along the line that, with a financially troubled franchisee in place, it is easier for a government to increase payments to that operator to continue service than to face the political odium of major service disruptions. The additional payments made by the Victorian Government during 2002 give some credence to this view, being widely seen as a bail-out in the local media at the time.

Were the successful franchisees victims of what some more charitably call the 'winner's curse'? In other words, did they simply get it wrong on the numbers, due to carelessness or ignorance. Possibly but this is a very charitable view, given the vast international experience of the franchisees! It might explain part of the outcome, given the extent of fare evasion that has been taking place on the system. However, the revenue estimated to be foregone because of fare evasion is about $50 million, only one-quarter the additional annual amount the State Treasurer has indicated will be required to keep the services going.

2. What about those managing the franchise process? Why did they accept bids that, to a seasoned transport planner, were unsustainable? Ideology is the likely answer. The whole process was grounded in a strongly held political view at the time that the private sector would do it better and that CT would deliver the result. Privatisation across a whole range of fields, where provision was previously in the hands of government agencies, was being undertaken during this time.

While 'before and after' assessments were undertaken as part of the analysis of franchisee bids, we know of no evidence to show that those managing the franchise process undertook benchmarking analyses with comparable public transport services overseas. Any such benchmarking would have shown, for example, that sustaining patronage increases of the order forecast by franchisees is exceptional, especially given projected increases in service kilometres, and that major reduction in subsidy requirements, as forecast, is uncommon if the start point is after a major programme of labour shedding has been undertaken. The franchise process seems to be partly guilty, at least, of being too caught up in the hype of promoting competition as an end in itself! Ideology, it seems, triumphed over understanding.

For the latter situation to have developed, a major gap at the *tactical level* in the public transport planning and service delivery process in the State must be recognised as a significant contributory factor. Following Macario (2001), we identify three elements in the configuration of an urban public transport system (as part of the wider urban transport/land use system).

- *The strategic level (S)* = government outcome goals for public transport, typically covering matters such as access, safety, economic and environmental dimensions. This is the level at which political trade-offs take place to define answers to meeting stakeholder needs subject to constrained budgets.
- *The tactical level (T)* = design of the transport system/service, including the roles to be performed by the respective modes, detailing of the policy means of translating the strategic outcome goals into operational specifications and drawing the boundaries between the roles of the regulator and the operator. This stage is normally the regulator's domain, as it is in Melbourne (although there is increasing international interest in the private sector pushing into this level). A common problem at the tactical level is the absence of adequate system definition, with individual operators left to pursue their own interests in a manner that misses broader

opportunities for economies of scale and scope. Grey areas include the boundaries between the regulator and the operator in system design and development. The tactical stage is widely recognised internationally as a major gap in the public transport planning/delivery system and Melbourne is no exception. 10–15 year service delivery contracts will always struggle when there are no intact system-wide planning/delivery frameworks to match. Our personal view is that the Victorian Government during the late 1990s lost sight of its public transport *system* as it focussed on franchising *separate services*. The subsequent Victorian Government is attempting to fill this tactical gap at present but is in recovery mode in so doing and will always struggle with the short term Treasury influence dominating budget processes, on which public transport is so dependent.

- *The operational level (O)* = production and consumption of transport services. If the strategic and tactical levels are well developed, this should be relatively easy!

Franchising in Melbourne essentially involved moving from public to private operators at the operational level, with little content at the strategic level, a weak tactical level and a team managing the franchising process who seemed to lack deep understanding of public transport economics. Again, ideology is no substitute for clear goals, a clear systemic view of how these will be achieved and a bit of knowledge about what will work and within what bounds. Franchising was doomed to failure in such an environment.

9.6.2. Competitive Tendering versus Negotiated (Performance-Based) Contracts

CT as a means of selecting franchisees (part of the ideology of the process) has some inherent problems that were not recognised adequately in the franchise process. After a decade or so during which CT experienced something of a honeymoon, there are now several areas of concern, such as:

- a tendency to focus too heavily on cost minimisation, at the expense of service quality, an issue highlighted many times in the THREDBO series of conferences on Competition and Ownership in Public Transport;
- open to the prospect of predatory pricing, as outlined by Alexandersson and Hulten (2003), although this is possibly less of an issue with longer term contracts, such as applied in Melbourne's franchises;
- open to the risk of franchisees playing capture the regulator, as discussed above;

- as a process for selecting several franchisees, it is not compatible with social welfare optimisation across the entire system (Hensher & Stanley, 2003 and Chapter 6), unless there are add-on negotiations at the system level between the regulator and set of operators; and
- it focuses on ex ante bidding positions rather than negotiated adjustments over time. In fact, the more that negotiated adjustments are used over time, to deal with changing circumstances, the weaker is the appeal of CT in terms of transparency (one of its main advantages).

These concerns do not rule out CT as a process but they weaken its appeal and suggest, for example, that it may have little advantage over *negotiated (performance based) contracts* if there are incumbent operators with good track records, provided those proven performers face the threat of competition if they stop performing. Service/cost benchmarking ('virtual competition') can assist this process of helping to ensure cost effective service delivery with negotiated contracts. This is the approach the Victorian Government is taking to re-franchising, an approach that is supported by the present authors.

The requirement for clear outcome goals and a well developed Tactical level must, of course, complement improved franchising processes at the operational level. This approach is consistent with the emerging trend in construction and other major project contracting towards *project alliancing*, where negotiated agreements and sharing of risks and rewards in an uncertain operational environment are features, with CT taking more of a back seat.[124]

If negotiated contracts are to play a larger role, how should remuneration be structured? The aim should be to line up key elements of operator remuneration with governmental outcome objectives from service provision. Governments typically support public transport because of:

- its capacity to meet social obligations (e.g., provision of transport options for transport disadvantaged groups); and
- its capacity to reduce the (unpriced) external costs of private car use for all sources of intra- and inter-sectoral externality, while providing benefits to public transport users.

Contractual remuneration systems should thus seek to separately reward service providers with respect to:

- the CSO of government in public transport service provision, through payment for provision of minimum service levels (MSLs, where these

MSLs will probably be expressed in high level terms such as vehicle kilometres of service per geographic area) at efficient cost levels (achieved through best-practice benchmarking). Key performance indicators (KPIs) can be used to reward/penalise operators for their performance in delivering against these CSOs, such KPIs relating (for example) to on-time running, safety, environmental performance, etc; and,

- incentive components related to (1) the creation of public transport user benefits and (2) additional external benefits from attracting passengers from private cars to public transport, both these incentive components flowing from service improvements.[125] The public transport user benefit component is an important ingredient since, under the regulated fare environments that characterise many public transport service contracts, operators are constrained in their ability to be rewarded for user benefits that flow from their service initiatives. The external cost component is vital because of the scale of these costs from road use, assessed nationally at about three times the scale of road user tax/charge payments for road use in Australia (BIC, 2001), and the urgency to take action to reduce the costs, as part of the development of more sustainable land transport systems.

The idea of PBCs in public transport is not new and has received strong and growing support in Europe, especially in Scandinavian countries (Carlquist, 2001; Johansen et al., 2001), where several Regional Authorities in Norway have rejected CT except as a last resort strategy (i.e., non-compliance under PBCs).

CT might still be used, of course, to develop a short-list of parties with whom negotiations would take place to select a preferred supplier for a new service or for a service where the incumbent is not meeting expectations.

9.6.3. Area Agreements/Quality Partnerships

In a multi-operator environment, how can social welfare optimisation across the system be achieved? This requires a mechanism for negotiating outcomes across the set of relevant operators and the regulator. This is an important element of service delivery at the system level because of:

- potential cost efficiencies and service quality improvements that are achievable if operators work in partnership to deliver services that cross modes and/or service franchises (e.g., system marketing; service connectivity);

- the scope for operators to deliver cost savings if governments are prepared to commit to forward programmes of service delivery enhancements, such as on-road priority treatments for trams and buses and forward funding commitments for improved MSLs (which may create opportunities for service rationalisation to achieve economies).

Quality Partnerships have been developed in the UK as a means of encouraging such system synergies. These are specific to the needs of the somewhat unique UK regulatory environment within which public transport operates but the general idea of having a formal mechanism to encourage partnerships or co-operation between groups of operators and the regulator is laudable.

The regulatory environment for metropolitan bus operation in Australia is different to that in the UK but the idea of using an agreement of some form between government and the set of bus operators in Melbourne to meet government transport objectives is being promoted by the Victorian bus industry as a means of contributing to service enhancement and more sustainable transport systems. Bus Association Victoria has proposed to the Victorian State Government that the industry and government sign off on an agreement that includes jointly agreed objectives. This would require the government to:

- make a minimum five year forward commitment to funding bus services at an increased level and to specifying a development plan that reflects these commitments (prepared in partnership with the industry and local government);
- commit to a five year programme of bus priority and related infrastructure and enforcement measures (again prepared in consultation with the industry and local government); and
- commit to a number of other procedural matters (e.g., relating to contract renewals).

The agreement then commits the bus industry (under such a quality partnership) to:

- ensuring that service efficiencies released by the government's commitments are converted to improved services at marginal cost;
- negotiating changes in franchise areas where this is needed to improve service effectiveness;
- opening up some service areas to CT (e.g., new cross-town services);[126]
- ensuring that all operators and their vehicles meet modern safety and environmental standards;
- meeting best-practice cost levels for service provision; and

- working co-operatively with the State and local governments on service development planning, contract reviews, etc.

Additional commitments are nominated for local government at the area level. Individual bus contracts would then reflect this overarching strategic framework.

While this approach has not been agreed at this time by the State Government, the Victorian bus industry is convinced that a partnership approach along such lines will lead to less expensive, more effective service provision at the metropolitan level. It will assist in breaking down the 'them and us' approach that typically characterises regulator-provider service contracts and associated relationships, encourage operators to price services taking into account government programme commitments, and protect the interests of the Victorian public, particularly because of the benchmarking approach. Most importantly, it will help to fill out the content of that most difficult tactical level within the service delivery framework.

9.6.4. Risk Sharing

While the intent of the franchise process was risk transfer to the private sector, the subsequent additional funding commitments by the State government indicate that the process failed miserably on this front. Subsequent thinking is to move from a process that simply seeks to transfer risk to the private sector to one that locates risk with the party most able to manage it.

Production risk is widely agreed to be a matter for the operator to manage. Revenue risk is more problematic, since it is influenced by some aspects of service delivery that are under operator control and by other things beyond operator control. For example, traffic congestion is affected by government road and traffic management programmes, including parking programmes, as well as by serendipity (e.g., traffic accidents due to bad weather). Traffic congestion affects the on-road performance of trams and buses and influences patronage levels. A government might expect a franchise bidder to make estimates of how this will impact on performance but, at the end of the day, it is a pretty hard ask in the absence of clear government intentions about its future road programmes on specific links. Some means of risk sharing on the revenue side is thus more likely to be a fair approach to contracts than simply expecting the operator to make educated guesses and build these into bids.

It is noteworthy that, in tenders for public transport services, there are few net cost contracts. Net cost contracts expose the operator to both production and revenue (including patronage) risk. Gross cost contracts remove the revenue side risk. These are far more common in public transport. Gross cost contracts (e.g., covering minimum service levels, as argued previously), with additional elements that reward an operator for building patronage and delivering additional service (e.g., of benefit to existing users) are tending to be the approach adopted in Australia.

9.7. MELBOURNE'S EMERGING NEW ARRANGEMENTS

The franchising of public transport in Victoria in 1999, as reviewed earlier in this paper, used CT processes to select franchisees. Following the failure of the National Express Group franchises and financial stresses on the remaining franchisees, the State Government is preparing replacement arrangements for the franchised services. These replacement arrangements seem likely to involve:

- one train and one tram franchise for Melbourne;
- centralised metropolitan network functions (e.g., marketing, revenue distribution from the common ticketing system) handled by a separate organisation whose shareholders will be the public transport franchisees;
- shorter franchise periods;
- an opportunity for the parties to negotiate a contract extension at the end of the (shorter) franchise, as an alternative to re-tendering; and
- remuneration arrangements that include an operational performance regime (with KPIs), a service quality incentive and a service growth incentive, the latter two elements being similar in intent to the user benefit and externality components of remuneration proposed by Hensher and Stanley (2003 and Chapter 6).

This approach is very much in line with the performance based approach and a significant move away from the blind adherence to CT that characterised the earlier process.

9.8. CONCLUDING COMMENTS

Franchising of public transport in Victoria provides a recent clear example of the need for realistic expectations in regulator–provider relationships.

The Victorian experience suggests that CT is no substitute for a hard-nosed assessment of what is possible in terms of service delivery and service costs. Franchising in Victoria, Mark II, will look different, relying more heavily on a (performance-linked) negotiated outcome with existing service providers who have survived the carnage from the first round of franchising.

The chapter argues that, once private sector public transport service providers are in place, negotiated contracts may provide the best opportunity to move closer to a social optimum in service provision than competitively tendered contracts. The threat of tendering is always available to encourage performance compliance but the Victorian experience is that CT can encourage excessively optimistic forecasts that are, in essence, undeliverable. The recent compelling evidence by Flyvbjerg, Bruzelius, and Rothengatter (2003) that large infrastructure projects in all sectors investigated (predominantly transportation) exhibit substantial cost overruns provides further supporting evidence to the Victorian Franchise experience.[127] Negotiated contracts may provide more sustainable service outcomes, with mechanisms such as benchmarking and open book accounting practices available to assure public accountability.

At the same time, successful public = private partnerships in public transport demand a well-developed Tactical level, where system planning work takes place. This area needs improvement in Australia. Public transport reform has tended to focus on the service provider. It is not time to shift the focus on to the regulator, where change has been far less than at service delivery level.

In a geographic area where there are multiple operators, with their own exclusive operating areas, the paper argues for government and the set of operators to agree a service development framework that includes major commitments from each side and where the emphasis is on partnering in the pursuit of service objectives.

CHAPTER 10

ESTABLISHING A FARE ELASTICITY REGIME FOR URBAN PASSENGER TRANSPORT[‡]

10.1. INTRODUCTION

Public transport operators increasingly use revenue optimising techniques in establishing mixtures of ticket types and fare levels. In predicting the response of the market to specific fare classes and levels (e.g., weekly ticket), knowledge of how various market segments respond to both the choice of ticket type within a public transport mode and the choice between modes is crucial to the outcome. In some circumstances the interest is in evaluating the patronage and revenue implications of variations in offered prices for the existing regime of fare classes; in other circumstances the interest is in changes in the fare class offerings either through deletions and/or additions of classes.

A missing ingredient in many operational studies is a matrix of appropriate direct and cross fare elasticities which relate to specific *fare classes* within a choice set of fare class opportunities. Surprisingly the research literature is relatively barren of empirical evidence that is rich enough to distinguish sensitivities to particular fare class offerings within a predefined choice set of offerings. Although there is a plethora of empirical evidence offered on direct elasticities (Oum, Tretheway, & Waters, 1992a,b; Goodwin, 1992; Luk & Hepburn, 1993), primarily treated as unweighted or weighted average fares within each public transport mode, as reviewed by Mayworm, Lago, and McEnroe (1980), Oum, Waters, and Yong (1992a), the extant literature offers limited evidence on cross-elasticities.

The empirical evidence on fare cross-elasticities is typically limited to aggregate measures across all fare types and levels, occasionally stratified by

[‡]This chapter first appeared as an article in the *Journal of Transport Economics and Policy.*

time of day and trip length. The majority of the evidence is based on studies using data collected in the 1970s and the early 1980s. The studies from which reported cross elasticities are drawn, however, do not consider the variations in cross-elasticities with respect to ticket type. The cross-elasticities for rail and bus with respect to bus and rail fares are very similar, with an unweighted average value of 0.24 ± 0.06. The car-to-public transport and public transport-to-car cross elasticities however are quite different. The average cross elasticity of car demand with respect to bus fares is 0.09 ± 0.07; and with respect to train fares it is 0.08 ± 0.03 (Mayworm et al., 1980; Oum et al., 1992a,b). These values are significantly higher for travel to CBD destinations where the propensity to use public transport is greater (i.e., higher initial modal share). Authors such as Glaister and Lewis (1978) have stated that the evidence on elasticities for the impact of public transport fares on car traffic for the off-peak is largely guesswork. Twenty years on, little appears to have changed.

A most recent study by Acutt and Dodgson (1996) derives aggregate cross elasticities based on the unweighted average fare per passenger journey in Great Britain in six markets (Intercity rail, Network South East, Regional railways, London underground, London buses and other local buses). The car-cross elasticities of demand with respect to the public transport fares range from 0.0005 for London Buses to 0.0118 for Intercity rail. The public transport cross-elasticities with respect to the price of petrol range from 0.013 for local buses to 0.094 for Intercity rail, within the range reported for studies from the 1970s and 1980s. Given the high degree of variability in site-specific results, public transport operators are wary of using default estimates from published sources; in addition the inability to disaggregate the estimates by fare class taking into account the full range of ticket types on offer raises fundamental concerns about the operational usefulness of the basket of published estimates. Elasticities related to specific ticket types are generally absent from the literature, and non-existent in Australia.

To obtain useful empirical elasticities applicable to particular ticket types, fare levels and mixes of ticket types offered requires site-specific empirical studies. This chapter departs from the reliance on average fares, distinguishing between fare classes across two public transport modes (train, bus) and the automobile for commuting travel in the Sydney Metropolitan area. Full matrices of direct and cross share elasticities are derived for three train fare classes, three bus fare classes and car travel for commuters on non-concessionary tickets. To evaluate sizeable variations in the levels of fares in each ticket class so that operators have extended policy intelligence beyond market experience, stated choice reponses are combined with knowledge of current modal attributes from revealed preference (RP) data to assess the ticket and mode choices made. Equivalent elasticities for non-commuters in the non-concessionary market have been obtained but are not reported herein.

The motivation for such disaggregation is two-fold. First public transport operators have little interest in empirical approaches which treat all fare classes as an equivalent one-way average fare-this is not a useful operational framework within which to make decisions on fare setting. Second, using a single representative fare can yield a biased 'average' fare elasticity, due to switching between ticket types. Third, empirical measurement of indicators of behavioural response to specific ticket types given the set of ticket types available will enable PT operators to identify the impact of these various ticket type (and level) scenarios on overall patronage and revenue. The incorporation of these elasticities into a Decision Support System (DSS) allows an operator to evaluate the implications of various fares policies on the net social benefit per dollar of 'subsidy' or community service obligation (CSO) payment provided as well as the EB such as traffic congestion reduction (Hensher & Raimond, 1995).

The chapter is organised as follows. Section 9.2 sets the ticket/mode choice modelling task within a microeconomic framework which guides the formulation of the indirect utility function associated with each alternative. Section 9.3 introduces a discrete choice model associated with the family of random utility models – heteroskedastic extreme value logit (HEVL) – which relaxes the strong assumption of constant variance in the unobserved effects to allow the cross-elasticities to break away from the equality constraint imposed in the multinomial logit model and within partitions of the popular nested logit model. Section 9.4 outlines the empirical context in which we source revealed and stated preference data to provide an enriched utility space for assessing behavioural responses to fare scenarios extending beyond the range observed in real markets. Section 9.5 presents the empirical evidence as a full matrix of direct and cross share elasticities for commuting travel. A set of conclusions highlight the major contribution of this study.

10.2. MICROECONOMIC SPECIFICATION OF THE INDIRECT UTILITY FUNCTION FOR CHOICE ALTERNATIVES

The functional form of the conditional indirect utility expression defining the set of attributes determining the probability of selecting a mode is typically assumed in RP models to be linear additive with the occasional use of logarithmic or Box-Cox transformations designed to improve the statistical 'fit' (e.g., Gaudry, Jara-Diaz, & Ortuzar, 1988) and occasionally specified with quadratic terms in a stated choice model with mean centered or orthogonal codes for each attribute. The derivation of the functional form from microeconomic theory is noticeably barren (with rare exception-see below) in most transportation *modal choice* applications, although many more examples exist in other transport applications, especially in automobile choice studies (e.g., Hensher, Smith, Milthorpe, & Barnard, 1992; Mannering & Winston, 1985; Train, 1986).

An exception in the modal choice literature is Jara-Diaz and Videla (1989) who have derived an appropriate functional form for the indirect utility expression for a discrete mode choice model from microeconomic principles, showing that the inclusion of the income effect is accommodated by the inclusion of a quadratic term in cost and segmentation of the sample by income, where the quadratic cost variable is statistically significant. It has been known for some time (but often ignored) that the inclusion of income as a separate explanatory variable serves only as a proxy for unobserved attributes of alternatives like comfort and convenience and other dimensions of taste, not captured by the taste weights (e.g., Hensher, 1984). Efforts to interact cost and income by dividing modal cost by the wage rate (e.g., Train & McFadden, 1978) implicitly treats income as an endogenous variable that depends on the number of hours worked at a given wage rate in contrast to its role as an exogenous variable in an individual's budget constraint.

Without realising it, the analysts estimating stated choice models with higher order cost attributes such as a quadratic are correctly incorporating a test of the presence/absence of the income effect in the discrete choice model; unfortunately they then introduce income as an additive explanatory variable in J-1 alternatives and interprete its taste weight as a measure of the marginal utility of income; in fact the marginal utility of income is a derivative of the cost variables as shown by Jara-Diaz and Videla (1989). Inclusion of income as an income effect requires its inclusion in the indirect utility expressions for *all* alternatives.

Formally, after Jara-Diaz and Videla (1989) and Hensher (2000a), for a sampled individual with a set of taste weights and income I, define a vector of non-modal trip goods X and a vector of associated prices P. The attributes of available modes, including trip cost, given by a vector A_j, are the observed and unobserved (by analyst) sources of utility, introduced into an indirect utility function evaluated by an individual in arriving at a choice. Imposing the separability condition on the numeraire non-trip goods and modal alternatives defined by a set of taste-weighted modal attributes, the individual is assumed to behave as if they are maximising utility by comparing the set of modal alternatives given the separability assumption for X and each of A_j, $j = 1, 2, \ldots, M$ modes:

$$\text{Max}\{\max[U_1(\mathbf{X}) + U_2(\mathbf{A_j})] | \mathbf{PX}' + c_j \leq I\};\ j \in \{1, \ldots, M\};\ \ \mathbf{X} \in x \quad (10.1)$$

A conditional indirect utility function can be derived from (10.1) by the application of Roy's identity, to yield

$$V(P,\ I - c_j,\ \mathbf{A_j}) = \mathbf{V}_1(\mathbf{P},\ I - c_j) + U_2(\mathbf{Q_j}) \quad (10.2)$$

where the maximum conditional indirect utility is attributed to the chosen alternative from a mutually exclusive set of alternatives.

Jara-Diaz and Videla (1989) demonstrate that if one takes a higher order Taylor series expansion this implies solving Eq. (10.3), re-expressed as Eq. (10.4).

$$\underset{j}{\text{Max}} \left[V_1(P,\ I) + \sum_{i=1}^{n-1} \frac{1}{i!} V_1^i(P, I)(-c_j)^i + \frac{1}{n!} V_1^n(P, I)(-c_j)^n + U_2(A_j) \right] \quad (10.3)$$

$$\underset{j}{\text{Max}} \left[\sum_{i=1}^{n-1} \frac{1}{i!} V_1^i(P, I)(-c_j)^i + \frac{1}{n!} V_1^n(P, I)(-c_j)^n + U_2(A_j) \right] \quad (10.4)$$

From Eq. (10.4) we have identified an empirical opportunity to evaluate the dependency of mode choice on income. Adding at least a quadratic term for cost (Eq. (10.5)) will establish the potential for income dependency. In the words of Jara-Diaz and Videla (1989, p. 396)

> …if a single model with utility in c_i, c_i^2, and A_i were run for the whole population, a null coefficient of c_i^2 would be consistent with a single coefficient for c_i. ,…, but a significant coefficient of c_i^2 would be contradictory with the model, since $\mathbf{V}_1^{\mathbf{i}}$ should be a function of I. Note that I is not explicitly included in V, but significant c_i^2 terms for each segment would suggest the existence of a more general … V(c_i, t_i, I) function.

$$V_i = \alpha_{0i} + \beta_{c1i} c_{1i} + \beta_{c2i} c_{2i}^2 + U_2(\mathbf{A}_i) \quad (10.5)$$

Thus if β_{c2i} is positive and statistically significant, an income effect exists and it is necessary to either segment by income so that income is affecting all alternatives in the choice set or income is accommodated in all indirect utility expressions. Having established that there is an income effect, and in the interest of maintaining a single discrete choice model, we need to introduce income into all indirect utility expressions in a way that is consistent with microeconomic theory. One appealing way is to adopt the approach promoted by Train and McFadden (1978), Hensher et al. (1992), Jara-Diaz and Ortuzar (1988), Jara-Diaz and Videla (1989) and Jara-Diaz (1996) where a first order expansion of indirect utility yields a model in which money cost is divided by the expenditure rate, the latter defined as the ratio of household income to leisure (or non-work) time. This formulation represents income as purchasing power.

If one were to undertake income segmentation, then to avoid an arbitrary segmentation one could calculate the marginal utility of income and identify the variation in the marginal utility of income over the personal income space of the sampled population, yielding a number of income groupings. Various classification methods are available to identify the number of 'homogeneous' segments (see Breiman, Friedman, Olshen, & Stone, 1993). The marginal utility of income is given by

$$\frac{\partial V_i}{\partial I} = \beta_{c1i} + 2\beta_{c2i}c_{2i} \tag{10.6}$$

The cross-elasticities derived from Eq. (10.5) when embedded within a discrete choice model, are choice elasticities. This chapter concentrates on establishing a full matrix of direct and cross choice (or share) fare elasticities using behaviourally more appealing econometric methods and RP data enriched by stated preference data. These estimates become the crucial input into a subsequent optimisation procedure proposed and implemented by Taplin, Hensher, and Smith (1997) to derive a matrix of ordinary demand elasticities. Taplin et al. (1997) argue that, for commuting trips, there are virtually no generation/suppression elasticities, and thus choice elasticities can approximate ordinary elasticities. The Slutsky income correction can also be omitted for commuting as the expenditure proportion is very small and the income elasticity difference is also small. In the absence of the income effect, symmetry requires equalisation of expenditure proportion weighted elasticities. As we show below, the empirical evidence rejects the presence of an income effect.

Although the choice elasticities can be treated as approximations to the ordinary elasticities, the estimated matrix will be reliable for pricing policy analysis only if it conforms to the symmetry condition for ordinary demand systems. To achieve this, Taplin et al. (1997) expressed each upper diagonal element (cross-elasticity) of the matrix as a symmetric function of the corresponding lower diagonal element. Then, each own-price elasticity was expressed as an exact function of the cross-elasticities in its column, using the choice condition that the trip-weighted elasticities in each column sum to zero. The lower diagonal elements were then adjusted, using a Newton procedure, to minimise the sum of the squared deviations from all of the original values. In effect, all elements of the matrix were subject to change. The condition that all cross-elasticities must be non-negative was also imposed, meaning that the modes and ticket types were assumed to be gross substitutes. See Taplin et al. (1997) for more details and empirical results.

10.3. SPECIFYING A CHOICE MODEL

The ticket type and mode choice model is based on the utility maximisation hypothesis which assumes that an individual's choice of ticket type conditional on mode and choice of mode is a reflection of the underlying preferences for each of the available alternatives, and that the individual selects the alternative with the highest utility. The utility that an individual associates with an alternative is specified as the sum of a deterministic component (that depends on observed attributes of the alternative and the individual) and a random component (that represents the effects of unobserved attributes of the individual and unobserved characteristics of the alternative).

In the majority of mode choice models, the random components of the utilities of the different alternatives are assumed to be independent and identically distributed (IID) with a type I extreme value distribution. This results in the multinomial logit model of mode choice (McFadden, 1981). The multinomial logit model has a simple and elegant closed-form mathematical structure, making it easy to estimate and interpret. However, it is saddled with the 'independence of irrelevant alternatives' (IIA) property at the individual level (Hensher & Johnson, 1981; Ben-Akiva & Lerman, 1985) which produces the well known restriction of equal cross-elasticities (see Ortuzar & Willumsen, 1994; Oppenheim, 1995 and the discussion below on scale). This property of equal proportionate change of unchanged modes is unlikely to represent actual choice behaviour in many situations. Such misrepresentation of choice behaviour can lead to misleading projections of mode share on a new or upgraded service and of diversion from existing modes.

The model developed herein falls under the category of non-IID models. Specifically, we develop a random utility model with independent, but non-identical random terms distributed with a type I extreme value distribution. This heteroscedastic extreme value model allows the utility of alternatives to differ in the amount of stochasticity (Bhat, 1995). Unequal variances of the random components is likely to occur when the variance of an unobserved variable that affects choice is different for different alternatives, giving a flexible cross-elasticity structure. For example, in a mode choice model, if comfort is an unobserved variable whose values vary considerably for the train mode (based on, say, the degree of crowding on different train lines) but little for the automobile mode, then the random components for the automobile and train modes will have different variances (Horowitz, 1981). We apply this model in the current study. Once we relax the constant variance assumption we have to distinguish taste and scale, to which we now turn.

10.3.1. The Inseparability of Taste and Scale

It has been well-known for some time that a fundamental link exists between the scale of the estimated parameters and the magnitude of the random component in all choice models based on Random Utility Theory (RUT) (see, e.g., Hensher & Johnson, 1981; Ben-Akiva & Lerman, 1985). Let

$$U_{iq} = V_{iq} + \varepsilon_{iq} \qquad (10.7)$$

where U_{iq} is the unobserved, latent utility individual q associates with alternative i; V_{iq} is the systematic, quantifiable proportion of utility which can be expressed in terms of observables of alternatives and consumers; and the ε_{iq}'s are the random or unobservable effects associated with the utility of alternative i and individual q. All RUT-based choice models are derived by making some assumptions about the distribution of the random effects; regardless of the particular assumption adopted, there is an embedded scale parameter, which is inversely related to the magnitude of the random component that cannot be separately identified from the taste parameters.

For example, to derive the multinomial logit (MNL) choice model from (10.7), we assume that the ε_{iq}'s are IID Type I Extreme Value (or Gumbel) distributed. The scale parameter $\lambda \geq 0$ of the Gumbel distribution is inversely proportional to the variance of the error component, thus, $\sigma^2_{iq} = \pi^2/6\lambda^2$. The fundamental identification problem of RUT-based choice models shows itself in the MNL model through the fact that the vector of parameters actually estimated from any given source of RUT-conformable preference data is actually $(\lambda\beta)$, where β is the vector of taste parameters. This is clearly seen in the full expression of the MNL choice probability:

$$P_{iq} = \frac{\exp(\lambda V_{iq})}{\sum\limits_{j \in Cq} \exp(\lambda V_{jq})} = \frac{\exp(\lambda\beta X_{iq})}{\sum\limits_{j \in C_q} \exp(\lambda\beta X_{iq})} \qquad (10.8)$$

where P_{iq} is the choice probability of alternative i for individual q, and the systematic utility $V_{iq} = \beta X_{iq}$. Since a given set of data is characterised by some value of λ, this constant is normalised to some value (say, one), and analysis proceeds as if $(\lambda\beta)$ were the taste parameters.[128]

The basic reason for the pervasiveness of this identification problem is that choice models are specifying a structural relationship between a categorical response and a latent variable (i.e., utility). As in structural equation models involving latent variables, it is necessary to specify both origin *and* variance (read 'scale') for the latent variable(s) to permit identification of utility function parameters.

Recognition of the role of the scale parameter in the estimation and interpretation of choice models has existed for many years (e.g., Williams, 1977), but got 'lost' in the dominating application of the MNL model. A renewed interest was triggered by the desire to combine sources of preference data, especially RP and stated preference (SP) data. The paradigm shift involving efforts to combine sources of preference data was inspired by Morikawa's (1989) insight that if data generation processes underlying SP and RP data are the same, model parameters should differ only by a constant of proportionality. Morikawa (1989) noted that the fundamental identification problem was confined to a single preference data source, and that the ratio of λ's in two or more sources of data could be identified. Morikawa's dissertation (1989), and subsequent work (e.g., Ben-Akiva & Morikawa, 1991) demonstrated that the ratio(s) of λ's could be estimated both sequentially (Swait, Louviere, & Williams, 1994) and simultaneously (Morikawa, 1989; Bradley & Daly, 1997; Hensher & Bradley, 1995; Bhat, 1995).

The estimation problem amounts to placing an equality restriction on the taste parameters of K preference data sources to be combined (i.e., $\beta_1 = \ldots = \beta_K = \beta$) and estimating K additional scale parameters ($\lambda_1, \ldots, \lambda_K$). One of these scale parameters must be fixed, say $\lambda_1 = 1$. The remaining scale parameters are then interpreted as inverse variance ratios with respect to the referent data source. The corresponding unrestricted model frees the taste parameters and the scale factors for the K data sources by estimating ($\lambda_k \beta_k$), $k = 1, \ldots, K$. The null hypothesis of interest is that of taste invariance across data sources, after permitting variance/reliability differences such an hypothesis can be tested using a likelihood ratio statistic.

This understanding of the role of the scale parameter has spawned several related research streams, most notably a 'data fusion' stream, primarily associated with travel choice modelling (e.g., Morikawa, 1989; Ben-Akiva & Morikawa, 1991; Hensher & Bradley, 1993; Swait, Louviere, & Williams, 1994), and a more general stream concerned with comparing and testing models estimated from any sources of preference data consistent with RUT (e.g., Swait & Louviere, 1993; Louviere, Fox, & Moore 1993; Swait et al., 1994; Louviere, 1994; Louviere & Hensher, 1996). The latter paradigm represents a more general view of combining data sources than the former.

First, it views the scale factor as an integral component of real behavioural processes, as opposed to the view that the scale is a nuisance parameter that must be accounted for to permit measurement of the true quantities of interest (e.g., taste parameters). Second, it encompasses a wider scope of data combinations, involving RP with RP and SP with SP, as well as the RP with SP combinations which are the sole interest of the 'data fusion' stream.

The existing studies using data from multiple sources have all adopted a constant variance assumption within the set of alternatives associated with each data set. They have set the scale parameter to 1.0 for one data set and rescaled the other data set by a scale parameter which is constant (but possibly not equal to 1.0) across the set of alternatives. This is acceptable where the analyst models two alternatives (in difference form); however the majority of applications involve more than two alternatives across a sample, even in situations where a sampled individual only faces two specific alternatives. The cross elasticities remain subject to the IID assumption and hence are potentially ill conditioned. In our study we relax the constant variance assumption and allow all scale parameters to differ within and between two data sets. We do this by a procedure known as a heteroscedastic extreme value (HEV) random utility model. Joint estimation is essential to enable direct comparability in rescaling between the RP and SP choice models, since only one alternative across both data sets has its variance on the unobserved effects arbitrarily set to 1.0.

10.3.2. Random Effects Heteroscedastic Extreme Value Model

Allenby and Ginter (1995), Bhat (1995) and Hensher (2000a) have recently implemented the HEV model on a single data source. Hensher (1997a, 1997b) has applied the Heteroscedastic HEV model to joint estimation of SP and RP data.

With respect to the indirect utility function (10.5), we assume that the data are cross-sectional (hence no temporal effects), there is no state dependence or serial dependence and tastes are homogenous. Specifically,

$$U_{iq} = \lambda_{iq}\alpha_i + \lambda_{iq}\beta X_{iq} + \varepsilon_{iq} \qquad (10.9)$$

Now assume that the λ_{iq} are equal to λ_i for all individuals q; in addition, assume they are independently, but not identically, distributed across alternatives according to the Type I Extreme Value density function $f(t) = \exp(-t)\exp(-\exp(-t)) = -F(t)\log(F(t))$, where $F(\cdot)$ is the corresponding cumulative distribution function. If the decision rule is maximal utility, then the choice probabilities are given by

$$P_{iq} = \int_{-\infty}^{\infty} \prod_{j \neq i} F(\lambda_j)[V_{iq} - V_{jq} + \varepsilon_{iq}]\lambda_i f(\lambda_i \varepsilon_{iq})\, \mathrm{d}\varepsilon_{iq} \tag{10.10}$$

The probabilities are evaluated numerically as there is no closed-form solution for this single dimensional integral. The integral can be approximated, for example, using Gauss–Laguerre quadrature (Press, Flannery, Teukolsky, & Vetterling, 1986). Computational experience has shown that a 68 point approximation is sufficient to reproduce taste parameter estimates (see Greene, 1996).

The heteroscedastic extreme value model nests the restrictive MNL and avoids the a priori identification of mutually exclusive market partitions of a nested MNL structure. It is parsimonious compared to the MNP model, introducing only $J-1$ additional parameters in the covariance matrix as opposed to the $[J(J-1)/2]-1$ additional parameters in the more general model (J is the total number of alternatives in the universal choice set). It also poses much less of a computational burden than the MNP, requiring only the evaluation of a one dimensional integral (independent of the number of alternatives); the MNP, of course, requires the evaluation of a J–1 dimensional integral. Importantly, in contrast to the multinomial probit model, the heteroscedastic extreme value model is easy to interpret and its behaviour is intuitive (Bhat, 1995).

The HEV model is flexible enough to allow differential cross-elasticities among all pairs of alternatives. Two alternatives will have the same elasticity only if they have the same scale parameter on the unobserved components of the indirect utility expressions for each alternative. The effect of a marginal change in the indirect utility of an alternative m on the probability of choosing alternative i may be written as Eq. (10.11) – see also Bhat (1995):

$$\frac{\partial P_i}{\partial V_m} = \int_{z=-\infty}^{z=+\infty} -\frac{1}{\lambda_m} \exp\left[\frac{-V_i + V_m - \lambda_i z}{\lambda_m}\right] \prod_{j \in C, j \neq i} \Lambda\left[\frac{V_i + V_j - \lambda_i z}{\lambda_j}\right] f(z)\, \mathrm{d}z \tag{10.11}$$

where $f(\cdot)$ is the probability density function, $z = \varepsilon_i/\lambda_i$. The impact of a marginal change in the indirect utility of alternative i on the probability of choosing i is given as

$$\frac{\partial P_i}{\partial V_i} = -\sum_{m \in C, m \neq i} \frac{\partial P_i}{\partial V_m} \tag{10.12}$$

The cross-elasticity for alternative i with respect to a change in the kth level of service variable in the mth alternative's observed utility, x_{km}, can be obtained as

$$\eta^{P_i}_{x_{km}} = \left[\frac{\partial P_i}{\partial V_m} \bigg/ P_i\right] \beta_k x_{km} \tag{10.13}$$

where β_k is the estimated taste weight on the kth fare variable.

Hensher (1997a, 1997b) has suggested that the HEV model is a useful device for identifying an appropriate partitioning of the MNL model into a nested structure, replacing the search for structure in nested MNL partitions. The reason for specifying a nested form of the MNL model is to accommodate systematic dependencies among the unobserved effects (leading to violation of the independence of irrelevant alternatives (IIA) condition), which are not handled properly by the MNL model. Since the HEV model is not closed form, the appeal to the practitioner is that a nested specification consistent with the HEV profile of λ_m will be easy to apply without the numerical integration implicit in (10.10).

The HEV model can be specified for multiple data sources, jointly estimated using a FIML specification to produce a set of alternative-specific lambdas across both RP and SP choice sets, normalising on an arbitrarily selected alternative.

10.4. THE EMPIRICAL CONTEXT

A survey of a sample of commuters and non-commuters was undertaken in the Sydney Metropolitan Area in 1995 as part of an inquiry into the mix and level of public transport fares. Within each market segment, patterns of modal and ticket use behaviour are captured to identify both current behaviour and the potential to switch to alternative modal and ticket use behaviour under a range of alternative fares policies for the government bus, ferry and train systems (Hensher & Raimond, 1995).

The choice of mode and ticket type is estimated using a mixture of RP and stated preference (SP) data. The RP data's strengths lie in reflecting the current state of market behaviour, whereas the SP data's strengths are that it mirrors a more robust and less restricted decision environment and presents a well-conditioned design matrix (Swait et al., 1994). RP data provides information on the current market equilibrium for the behaviour of interest and is useful for short-term forecasting of departures from the current equilibrium. In contrast SP data is especially rich in attribute trade-off information, but is to some extent affected by the degree of 'contextual realism' that we can establish for the respondents (Hensher, 1994). In deriving estimates of elasticities, the set of choice probabilities must reflect observed market behaviour (i.e., market shares), and hence we use the RP model enriched by the parameter estimates produced from the SP data appropriately re-scaled for each alternative when transferred to the RP model.

10.4.1. Sourcing Revealed and Stated Preference Data

In the survey, respondents were asked to think about the last commuter trip they made, where they went, how they travelled, how much it cost, etc.; then they were asked to describe another way they could have made that trip if their current mode was not available. The current behaviour provides the RP data. Importantly, through limiting the RP choice set at the individual level to the preferred binary set, we might expect the variances of the unobserved effects to be more similar than if the universal but finite choice set were evaluated at the individual respondent level. Since the estimated variance associated with an alternative is obtained across the entire sample, however, the strength of this variance similarity will be weakened. The extent of weakening similarity is an empirical issue, but is does raise an interesting topic for future research, especially given the popularity of revealing the individual's choice set through asking each individual to reveal their bounded choice set.

The stated preference component of the survey varies public transport fares of current and alternative methods of travel under a series of different pricing scenarios. The choice set was determined exogenously based on the physical availability of each alternative (including the availability of a car as a driver or passenger) for the journey to work. Ticket prices were varied from current levels to 50% above and below current levels. Each respondent was presented with four replications or scenarios for the available choice set. Table 10.1 is an example of one replication for the bus versus train context. Three fractional factorial designs were developed for bus versus train (8 ticket types), bus versus car (4 ticket types and car) and train versus car (4 ticket types and car). The choice response identifies the mode of transport and, for public transport, the fare they would use. Automobile operating cost was set at the marginal perceived cost of 9 cents/km.

Given the primary emphasis is on developing a full matrix of direct and cross elasticities for mode-specific public transport fares under alternative choice sets of ticket types, we designed a sample that captured a sufficient number of travellers currently choosing each of the available modes (including car) and available ticket types in each of the market segments. Inner, middle and outer areas of Sydney are sampled in roughly equal proportions, as is each mode.

Table 10.1. Illustrative Set of Show Cards for the SP Experiment 1: Bus or Train for a Short Trip. *You have told us that you could either use a Bus or a Train as the main form of transport to travel to the destination that we have discussed. If public transport fares changed and were priced as below, would you have used Bus or Train as the main form of transport for your trip? Which ticket type would you choose?*

Bus Fares	Train Fares
Single $0.60	Single $0.80
TravelTen $4.00	Off peak return $0.90
(10 single trips)	*(purchase after 9am)*
TravelPass $8.60	Weekly $6.80
(7 days bus/ferry)	*(7 days train only)*
TravelPass $10.00	TravelPass $10.00
(7 days bus/ferry/train)	*(7 days bus/ferry/train)*

A face to face home interview was undertaken with start points generated by randomly choosing postcodes within each Statistical Local Area in Sydney (Hensher & Raimond, 1995). Within each postcode, a random street was chosen to be cluster sampled. The sampling unit is the mode to ensure there are enough sampled individuals currently choosing each of the alternative modes. Given that the RP choice set is choice based, correction of the RP subset of alternatives in the joint SP-RP model was undertaken by weighting that part of the likelihood function applying to the RP alternatives by the ratio of the sample shares to the known population shares. This guarantees the reproduction of the base market shares at the ticket type level for the RP choice set. Such weighting does not apply to the SP choice set. In addition, all observations are exogenously weighted by the distribution of personal income for commuter demand as revealed in the 1991 Sydney Travel Survey. Although the survey included ferry and jet cat options, we have excluded them from the current analysis, since many cities have only trains and buses available as public transport competing with the automobile. Taxis were excluded from the commuter sample.

10.4.2. Developing the Stated Choice Experiment

One of the challenges associated with using a stated choice approach is the need to present individuals with an experiment which offers realistic scenarios to all respondents. Given that people use different modes and travel over greatly varying distances, it is necessary to develop a range of showcards with different modal combinations and different travel distances. Answers in the questionnaire tell the interviewer which showcards are appropriate for which respondents.

The showcards developed for this study cover every combination of main mode (car, train, bus) and have levels for short trips (less than 15 min), medium trips (15–30 min) and long trips (over 30 min). These times refer to the length of time spent in the main mode only, not the access, egress or waiting times. To keep the experiment and sample size to a manageable size, the public transport ticket categories were collapsed down to those most frequently used. Table 10.2 shows the distribution of ticket sales in 1991.

Using the distribution in Table 10.2, an experimental design was developed based on 1 car, 4 train tickets (single, off-peak, weekly and travel pass) and 4 bus tickets (single, travel ten, combined bus-ferry travel pass and combined bus-ferry-train travel pass) – a total of 9 alternatives that are hypothetically possible for any respondent. The full range of fares in the choice experiment are summarised in Table 10.3.

Table 10.2. Profile of Public Transport Commuters by Ticket Type.

Ticket Type	Frequency	Relative Frequency (%)
Metroten – blue	12,137	4.2
Metroten – green	2,801	1.0
Metroten – orange	226	0.1
Metroten – red	17,426	6.0
Other	4,287	1.5
Quarterly – not travel pass	4,444	1.5
Return ticket	31,832	11.0
Single ticket	41,989	14.4
TravelPass – blue	10,282	3.5
TravelPass – brown	679	0.2
TravelPass – green	6,958	2.4
TravelPass – orange	683	0.2
TravelPass – pink	2,920	1.0
TravelPass – purple	482	0.2
TravelPass – red	20,159	6.9
TravelPass – two zone	595	0.2
TravelPass – yellow	555	0.2
Weekly – not travel pass	119,632	41.2
Yearly – not travel pass	12,416	4.3
Total	290,503	100.0

Source: 1991 Sydney Travel Survey. Data are based on home to work and work to home trips for an average weekday and include Sydney Region residents only.

Table 10.3. The Stated Choice Experiment Fare Categories and Levels.

	Low Fare	Current Fare	High Fare
Train: Single (off peak return)			
Short	$0.80 ($0.90)	$1.60 ($1.80)	$2.40 ($2.60)
Medium	$1.30 ($1.40)	$2.60 ($2.80)	$3.90 ($4.20)
Long	$1.80 ($2.00)	$3.60 ($4.00)	$5.40 ($6.00)
Train: Weekly			
Short	$6.80	$11.50	$18.30
Medium	$9.70	$19.40	$29.00
Long	$13.20	$26.00	$40.00
Train: TravelPass			
Short	$10.00	$20.00	$30.00
Medium	$14.00	$28.00	$42.00
Long	$20.00	$39.00	$59.00
Bus: Single			
Short	$0.60	$1.20	$1.80
Medium	$1.30	$2.50	$3.80
Long	$2.00	$3.90	$5.90
Bus: TravelTen			
Short	$4.00	$8.00	$12.00
Medium	$8.00	$16.00	$24.00
Long	$16.00	$32.00	$48.00
Bus: TravelPass (bus/ferry)			
Short	$8.60	$17.10	$26.00
Medium	$11.70	$23.00	$35.00
Long	$17.20	$34.00	$52.00
Bus: TravelPass (bus/ferry/train)			
Short	$10.00	$20.00	$30.00
Medium	$14.00	$28.00	$42.00
Long	$19.50	$39.00	$59.00

10.5. EMPIRICAL RESULTS

10.5.1. Response Rates

The effective response rate was 37%, which is about average for surveys of equivalent length (Richardson, Ampt, & Meyburg, 1995). While the full sample collected was 649 cases, not all cases had sufficient data to be suitable for modelling. The sample is a fairly broad representation of the Sydney population, though males and the elderly is slightly under-represented (see Hensher & Raimond, 1995 for further details).

10.5.2. Empirical Models

The final model jointly estimated with 7 SP alternatives and 7 RP alternatives is presented in Table 10.4 (HEV). An MNL model estimated as a joint SP-RP model using the method developed by Bradley and Daly (1997) where the scale parameter is set equal to 1.0 for the RP choice set and allowed to be free but fixed across the SP choice set, was also estimated and is summarised in Table 10.5. Summary statistics describing the attributes of each indirect utility expression are given in Table 10.6, together with sample size. The mean of cost for multi-trip tickets is derived from the ticket price divided by the number of one-way trips actually undertaken by each commuter, allowing for the use of the ticket for non-commuting travel (a point often overlooked). The off-peak train single option was deleted because so few commuters choose it; in addition we had to combine the two bus travel passes (bus/ferry and bus/ferry/train) to secure enough commuters choosing one of these ticket types. McFadden (1984, p. 1442) has stated that

> As a rule of thumb, sample sizes which yield less than thirty responses per alternative produce estimators which cannot be analysed reliably by asymptotic methods.

The distribution of SP costs encompass the RP cost levels although the composition of the sample in terms of captivity to public transport *given a ticket type* differs quite markedly. This is expected given that all SP fare options within a mode were offered to each respondent whereas the RP data define two alternatives – the chosen ticket (or mode) and one viable alternative. One most notable difference is in multi-use tickets (e.g., train weekly, travel pass and bus travel ten) where the higher incidence of RP captivity to public transport reflects reality much better than does the SP profile. Including captivity and car availability in both the SP and RP choice sets however is a valid application of contextual impacts on choices. Ceteris paribus, one expects there to be greater substitution between fare classes than between modes as a result of higher incidences of public transport captivity. Importantly this effect can be observed and modelled when ticket types are treated endogenously. Previous studies which evaluate modal choice in terms of an average fare or a single fare type per commuter are unable to represent the amount of movement between ticket types as a contributing response to price changes. It is suggested herein that modal choice models which ignore

Table 10.4. HEV Model: Joint Estimation of SP and RP Choices to Evaluate the Presence of an Income Effect.

Attribute	Units	Alternative	SP Parameter Estimates	*t*-Value	RP Parameter Estimates	*t*-Value
One-way trip cost (or fare)	Dollars	All	−0.34966	−4.15	−0.34966	−4.15
Trip cost squared	Dollars	All	0.00365	0.79	0.00365	0.79
Door-to-door time	Minutes	Train	−0.01862	−4.44	−0.01862	−4.44
Door-to-door time	Minutes	Bus	−0.02659	−4.95	−0.02659	−4.95
Door-to-door time	Minutes	Car	−0.02517	−5.86	−0.02517	−5.86
Train single constant		Train	7.8198	3.84	8.7959	3.98
Train weekly constant		Train	8.2091	3.93	10.319	4.17
Train travel pass constant		Train	8.0665	3.90	9.2150	3.31
Bus single constant		Bus	8.3482	4.00	9.4006	4.13
Bus travel ten constant		Bus	8.2200	3.95	9.6701	4.08
Bus travel pass constant		Bus	8.1234	3.94	9.7870	3.34
Car constant		Car	–	–	–	–
Captive to train dummy		Train	1.0657	2.42	1.0657	2.42
Captive to bus dummy		Bus	1.4792	3.44	1.4792	3.44
Car availability dummy	1,0	Car	9.2935	4.09	9.2935	4.09

Scale parameters (standard deviation in parentheses)						
Train single		Train	0.962 (1.3336)	3.58	1.515 (0.8467)	3.73
Train weekly		Train	0.527 (2.4358)	2.46	0.340 (3.7723)	1.33
Train travel pass		Train	0.559 (2.2941)	3.57	0.557 (2.3045)	1.11
Bus single		Bus	0.510 (2.5139)	3.14	0.307 (4.1828)	1.16
Bus travel ten		Bus	0.780 (1.6448)	3.51	0.353 (3.6309)	1.18
Bus travel pass		Bus	0.515 (2.4926)	3.01	0.615 (2.0844)	1.82
Car		Car	3.338 (0.3842)	4.25	1.283 (1.0000)	Fixed
Value of travel time savings						
Train	\$/h	3.36				
Bus	\$/h	4.75				
Car	\$/h	4.60				
Sample size		1824				
Log-likelihood at convergence		−1547.64				
Pseudo R^2		0.730				

Note: (1) Value of travel time savings is calculated per one-way trip based on average number of one-way trips per ticket. (2) The scale parameter is derived from the standard deviation estimate, the latter being set equal to 1.0 for the car alternative in the SP choice set. Given that $\sigma_{iq}^2 = \pi^2/6\lambda^2$, it follows that λ will not be based on 1.0.

Table 10.5. MNL Model: Joint Estimation of SP and RP Choices.

Attribute	Units	Alternative	SP Parameter Estimates	*t*-Value	RP Parameter Estimates	*t*-Value
One-way trip cost	Dollars	All	−0.45320	−9.74	−0.45320	−9.74
Door-to-door time	Minutes	Train	−0.04072	−10.49	−0.04072	−10.49
Door-to-door time	Minutes	Bus	−0.04699	−10.07	−0.04699	−10.07
Door-to-door time	Minutes	Car	−0.03630	−10.67	−0.03630	−10.67
Train single constant		Train	1.8519	5.90	3.2493	8.36
Train weekly constant		Train	2.1117	6.45	4.7789	12.03
Train travel pass constant		Train	1.5604	4.90	3.3961	5.16
Bus single constant		Bus	1.7664	5.65	3.1103	7.28
Bus travel ten constant		Bus	2.0134	6.36	3.6646	6.87
Bus travel pass constant		Bus	1.4553	4.50	4.2722	7.25
Car constant		Car	–		–	
Captive to train dummy		Train	1.5632	4.21	1.5632	4.21
Captive to bus dummy		Bus	2.0861	4.73	2.0861	4.73
Car availability dummy	1,0	Car	2.9438	9.10	2.9438	9.10
Scale parameters (standard deviation in parentheses)						
Train single		Train	0.954	10.47	1.0	
Train weekly		Train	0.954	10.47	1.0	
Train travel pass		Train	0.954	10.47	1.0	
Bus single		Bus	0.954	10.47	1.0	
Bus travel ten		Bus	0.954	10.47	1.0	
Bus travel pass		Bus	0.954	10.47	1.0	
Car		Car	0.954	10.47	1.0	
Value of travel time savings						
Train	\$/h	5.41				
Bus	\$/h	6.22				
Car	\$/h	4.81				
Sample size		1824				
Log-likelihood at convergence		−2322.43				
Pseudo R^2		0.774				

Table 10.6. Summary Statistics of Estimation Sample (Standard Deviations in Parentheses).

	Out of Pocket Cost ($)	Door to Door Time (min)	Captive to PT (Proportion)	Car Available (Proportion)	Sample Size
Stated preference sub-sample					
Alternative					
Total sample					
Train single	2.89 (1.50)	69.4 (29.6)	0.081	–	540
Train weekly	2.11 (1.90)	69.4 (29.6)	0.081	–	540
Train travel pass	3.18 (1.61)	69.4 (29.6)	0.081	–	540
Bus single	2.34 (1.49)	53.6 (26.5)	0.119	–	472
Bus travel ten	1.67 (1.23)	53.6 (26.5)	0.119	–	472
Bus travel pass	1.54 (0.83)	53.6 (26.4)	0.119	–	472
Car	2.88 (2.63)	44.9 (33.3)	–	0.80	812
Sample who chose that alternative					
Train single	2.09 (1.18)	57.18 (31.3)	0.112	–	98
Train weekly	1.90 (0.92)	74.09 (28.3)	0.127	–	150
Train travel pass	2.31 (1.28)	71.58 (31.3)	0.083	–	60
Bus single	1.36 (0.63)	37.55 (21.4)	0.182	–	55
Bus travel ten	1.15 (0.74)	42.21 (21.3)	0.208	–	77
Bus travel pass	1.55 (1.16)	48.56 (21.2)	0.365	–	52
Car	2.14 (2.07)	34.17 (23.8)	–	1.0	420
Revealed preference sub-sample					
Alternative					
Total sample					
Train single	1.64 (1.19)	64.29 (31.1)	0.044	–	272
Train weekly	2.46 (0.85)	72.58 (28.6)	0.317	–	248
Train travel pass	1.28 (1.32)	79.60 (27.8)	0.200	–	45
Bus single	2.37 (1.29)	51.26 (24.5)	0.074	–	324
Bus travel ten	1.17 (0.67)	60.60 (32.8)	0.160	–	100
Bus travel pass	1.94 (0.31)	46.25 (20.7)	0.333	–	48
Car	2.12 (2.04)	44.88 (33.3)	–	0.80	812
Sample who chose that alternative					
Train single	2.15 (1.21)	59.91 (30.7)	0.088		136
Train weekly	2.59 (0.79)	74.82 (27.8)	0.130		216
Train travel pass	2.40 (1.50)	82.50 (40.1)	0.500		32
Bus single	2.05 (1.19)	38.33 (19.0)	0.250		96
Bus travel ten	1.08 (0.54)	37.08 (21.7)	0.333		48
Bus travel pass	1.99 (0.30)	47.78 (20.9)	0.444		36
Car	1.39 (1.03)	33.23 (23.3)	–	1.00	372

the reality of ticket-type switching may result in some switching between modes which would otherwise had been represented by ticket switching within a mode, potentially overestimating the impact of fares policies on modal choice, unless within-mode cross elasticities approach zero.

Fare or cost was included initially as a non-linear effect truncated at the second-order level (Eq. (10.5)). The quadratic of cost was found to be positive but not statistically significant (Table 10.4) under the non-constant variance assumption. To ensure that cost and cost-squared are not highly correlated they were mean centred for estimation. This reduced the partial correlation from 0.95 to 0.33. Interestingly the quadratic of cost was highly significant (*t*-value of 9.06) in a constant variance multinomial logit model, suggesting the presence of confoundment of scale and taste weight, which is separately identified under the HEV specification. Previous studies that have investigated the presence of an income effect (e.g., Jara-Diaz & Ortuzar, 1988; Jara-Diaz & Videla, 1989 with a universal choice set of 9 alternatives) may have indeed made an incorrect interpretation of the presence or absence of an income effect because of the reliance on a simple multinomial logit model which surpresses the unobserved variance to be equal across the alternatives. Consequently we conclude the absence of an income effect in the present study; which may be intuitively sensible given the small amount of an individual's budget in Sydney devoted to commuting use-related marginal costs.

The level of service attributes represented by mode-specific door-to-door travel time are statistically significant, producing behavioural values of travel time savings at the sample mean of fare or cost ranging from \$3.36 per person hour for train and \$4.60 per person hour for car and \$4.75 per person hour for bus. The public transport values are substantially lower than those derived from the multinomial logit model (\$5.41 for train and \$6.22 for bus), however the car value is slightly lower (MNL value of \$4.81). The HEV and MNL car values are comparable to that found in another study by Hensher for Sydney in the context of route choice, of \$4.35 per person hour (Hensher, 1997a, 1997b). These results are very similar to what we have found in a commuter mode choice study for six capital cities in Australia. Although it is early evidence, one might be tempted to suggest that relaxing the constant variance assumption redistributes the potential time benefits of modes in favour of the automobile, away from the relatively inflated behavioural values of travel time savings for public transport:

> … in the basic logit model … [as] … the result of failure to account for some unobserved influences on relative utility which are suppressed through the constant variance assumption and consequently 'distributed' to the observed effects (Hensher, 2000a, p. 11).

If one identified an income effect, then personal income should be introduced into the utility expression for *every* alternative, in line with the theoretical requirement. We estimated a model with explicit treatment of the income effect, by dividing cost by the expenditure rate. The estimates are available on request (since only one variable differed in the two models); however a comparison with the results in Table 10.4 on a likelihood ratio test yields a ratio of −52.06 which with one degree of freedom difference leads us to conclude that the two models are significantly different in goodness of fit. The zero income effect model has greater explanatory power over the income effect model.

To our knowledge this is the first study to combine the behavioural realism of free variance in the unobserved effects together with a theoretically derived functional specification for the attributes in the indirect utility expressions and the richness of data fusion through mixing SP and RP choice sets. This mixture adds diversity and robustness to the process for deriving the matrix of direct and cross choice elasticities for input into a final optimisation stage to yield a matrix of ordinary demand elasticities as shown in Taplin et al. (1997).

When the scale differences across all alternatives in both the SP and RP data are taken into account, the parameter estimates for each attribute common to an alternative appearing in both the SP and RP data sets should be generic. There is no microeconomic theoretical reason for treating them as data set specific which has traditionally been the assumption in both sequential and joint estimation of SP-RP models resulting in a single scale parameter attributed to all alternatives in a specific data set (e.g., Morikawa, 1989; Hensher & Bradley, 1993; Swait et al., 1994).

10.5.3. Fare Type and Car Cost Direct and Cross Share Elasticities

A HEVL model relaxes the constant variance assumption of the standard multinomial logit model allowing the cross-elasticities to be alternative specific. The final set of direct and cross-elasticities are reported in Table 10.7. The reported results are probability weighted average estimates, derived from estimates for each individual in the sample. Each column provides one direct share elasticity and 6 cross share elasticities. A direct or cross elasticity represents the relationship between a percentage change in fare level and a percentage change in the proportion of daily one-way trips by the particular mode and ticket type.

For example, the column headed TS tells us that a 1% increase in the train single fare leads to a 0.218% reduction in the proportion of daily

Table 10.7. Direct and Cross Share Elasticities.

	TS	TW	TP	BS	BT	BP	Car
Train single (TS)	−0.218 (−0.702) [−0.161 −0.517] {−0.057, −0.317}	0.001 (0.289) [0.146, 0.110] {0.134, 0.073}	0.001 (0.149) [0.031, 0.067] {0.004, 0.039}	0.057 (0.012) [0.052, 0.035] {0.048, 0.023}	0.005 (0.015) [0.025, 0.041] {0.012, 0.029}	0.005 (0.009) [0.021, 0.024] {0.018, 0.018}	0.196 (0.194) [0.427, 0.601] {0.134, 0.199}
Train weekly (TW)	0.001 (0.213) [0.062 , 0.087] {0.054, 0.053}	−0.093 (−0.635) [−0.057, −0.313] {−0.018, −0.197}	0.001 (0.358) [0.031, 0.067] {0.004, 0.039}	0.001 (0.025) [0.052, 0.035] {0.048, 0.023}	0.001 (0.024) [0.025, 0.041] {0.012, 0.029}	0.006 (0.019) [0.021, 0.024] {0.018, 0.018}	0.092 (0.229) [0.427, 0.601] {0.134, 0.199}
Train travel pass (TP)	0.001 (0.210) [0.062 , 0.087] {0.054, 0.053}	0.001 (0.653) [0.146, 0.110] {0.134, 0.073}	−0.196 (−1.23) [−0.111, −0.597] {−0.002, −0.368}	0.001 (0.023) [0.052, 0.035] {0.048, 0.023}	0.012 (0.022) [0.025, 0.041] {0.012, 0.029}	0.001 (0.017) [0.021, 0.024] {0.018, 0.018}	0.335 (0.218) [0.427, 0.601] {0.134, 0.199}
Bus single (BS)	0.067 (0.023) [0.062 , 0.087] {0.054, 0.053}	0.001 (0.053) [0.146, 0.110] {0.134, 0.073}	0.001 (0.031) [0.031, 0.067] {0.004, 0.039}	−0.357 (−0.914) [−0.217, −0.418] {−0.141, −0.239}	0.001 (0.248) [0.025, 0.041] {0.012, 0.029}	0.001 (0.286) [0.021, 0.024] {0.018, 0.018}	0.116 (0.096) [0.427, 0.601] {0.134, 0.199}
Bus travel ten (BT)	0.020 (0.020) [0.062 , 0.087] {0.054, 0.053}	0.004 (0.037) [0.146, 0.110] {0.134, 0.073}	0.002 (0.023) [0.031, 0.067] {0.004, 0.039}	0.001 (0.206) [0.052, 0.035] {0.048, 0.023}	−0.160 (−0.462) [−0.083, −0.268] {−0.017, −0.159}	0.001 (0.163) [0.021, 0.024] {0.018, 0.018}	0.121 (0.090) [0.427, 0.601] {0.134, 0.199}
Bus travel pass (BP)	0.007 (0.025) [0.062 , 0.087] {0.054, 0.053}	0.036 (0.063) [0.146, 0.110] {0.134, 0.073}	0.001 (0.034) [0.031, 0.067] {0.004, 0.039}	0.001 (0.395) [0.052, 0.035] {0.048, 0.023}	0.001 (0.290) [0.025, 0.041] {0.012, 0.029}	−0.098 (−0.700) [−0.072, −0.293] {−0.005, −0.154}	0.020 (0.103) [0.427, 0.601] {0.134, 0.199}
Car (C1)	0.053 (0.014) [0.062 , 0.087] {0.054, 0.053}	0.042 (0.023) [0.146, 0.110] {0.134, 0.073}	0.003 (0.013) [0.031, 0.067] {0.004, 0.039}	0.066 (0.009) [0.052, 0.035] {0.048, 0.023}	0.016 (0.011) [0.025, 0.041] {0.012, 0.029}	0.003 (0.006) [0.021, 0.024] {0.018, 0.018}	−0.197 (−0.138) [−0.130, −0.200] {−0.265, −0.361}

Note: Elasticities relate to the price per one-way trip. The RP elasticity precedes the SP elasticity in any pair. SP direct and cross-elasticities from the HEV model (Table 10.5) are in parentheses ( ). The direct elasticities from the stand alone RP and SP MNL models are in square brackets [ ]. Cross-elasticities for the stand-alone SP MNL model and the stand-alone RP MNL model are given in square brackets [ ]. The MNL RP and SP direct and cross-elasticities are in curly brackets { } from the joint SP-RP MNL model in Table 10.6. The interpretation for a speciÞc fare class is obtained under each column heading.

one-way trips by train on a single fare. In addition, this 1% single fare increase leads to a 0.001% higher proportion of one-way trips on a train travel pass and 0.001% increase in one-way trips on a train weekly ticket.

The set of fare elasticities associated with a joint SP-RP model are based on the use of the SP parameter estimates for fare and cost, rescaled into the RP model, which provides the choice probabilities and fare (or car cost) attribute levels. Since the HEV model does not have a closed form solution, the elasticity formula (given in Eq. (10.13)) is complex requiring the derivation of integrals by quadrature for Eq. (10.10). For completeness and comparison, we have reported in Table 10.7, the direct and cross elasticities from the SP partition of the joint SP-RP HEV model, the joint SP-RP MNL model and the stand-alone SP-MNL and RP-MNL model. The cross elasticities for a joint and stand-alone MNL model are uninformative.

The results offer many implications. The differences in direct elasticities between the SP and RP choice sets reflects the different probabilities of choice. As is well known, although often ignored, studies which derive elasticities from stand-alone SP models produce different switching propensities to the RP estimates because the SP experiment is often searching in a more expansive utility space of choice opportunities, producing a different probability profile than an RP model. It is necessary to 'return' the parameter power of an SP model back to the RP space regardless of whether new alternatives are introduced to the market or existing alternatives removed. Since an elasticity calculation uses three inputs – a predicted choice probability, a taste weight (and a scale parameter in an HEV model) and an attribute level, the appropriate probabilities for predicting switching behaviour in the current market must come from a base or enhanced RP model. Thus the only elasticities of interest are those from the RP alternatives in the SP-RP-HEV model (reported as the first value in the top row of each cell), and the RP alternatives in the SP-RP MNL model (reported as the first value in the third row of each cell). The RP direct elasticities for public transport are lower than the SP equivalences; however since the results are driven primarily by probability differences, some elasticities must be higher for the SP model. This is the case for the car mode; explained by the fact that the SP percentage choosing the car is less than the actual market share. The remaining discussion is limited to the first elasticity value in the first and third row of each cell.

For HEV direct elasticities, sensitivity within the commuter rail and bus markets decreases as we move from a single ticket through to multiple-trip tickets with the exception of train travel pass. For the MNL direct elasticities, the trend downwards in sensitivity is consistent across both train and bus markets. This has interesting implications for a fares policy – increasing the price of a multi-use ticket, especially in the bus market, offers higher revenue growth prospects for small losses of patronage than is the case for single tickets. The HEV cross elasticities suggest that there is more movement between modes for a given fare class than between fare classes within modes. The strongest cross-mode substitution occurs between train and bus single tickets, although it is *not* symmetrical, with cross elasticities of 0.067 and 0.057 for train to bus and bus to train respectively. The largest cross elasticity is 0.335 for the switch from car to train travel pass in the event of a price increase in car use. The MNL cross elasticities are uninformative. The extant empirical evidence suggests that trains have more success in attracting commuters out of cars than do buses. A travel pass per trip is the best VM train fare (see Table 10.4) where the price per one-way trip is \$1.28 compared to \$1.64 for a train single and \$2.46 for a travel ten ticket. All of the cross elasticities associated with car operating costs are sizeable compared to the other modal switching contexts. Interestingly, changes in public transport fares across all ticket categories have less of an impact on car use than does a change in car costs have on public transport use.

A comparison of the HEV and MNL RP elasticities shows a systematically lower set of direct elasticity estimates for all public transport alternatives in the MNL model (and vice versa for car); thus we might conclude that an SP model tends to produce lower elasticities than its RP counterpart where the SP choice probabilities are higher than the RP probabilities (which is the situation herein). The MNL direct elasticity estimates for public transport alternatives tend to be lower than their HEV counterparts in both RP and SP models (and vice versa for car). The implication, *if generalisable (given the observation that the less chosen modes in an RP setting are chosen more often in an SP setting)*, is that all previous studies which have used an MNL framework and/or a stand-alone SP model specification have made sizeable errors in their estimation of direct share elasticities. Since the majority of travel choice studies have adopted this MNL framework, the findings are quite troublesome for the extant literature.

Finally, if we take the extant empirical evidence on cross elasticities for Sydney and compare it with Table 10.7, we have a number of estimates for Sydney, which can be directly compared. The estimate for Sydney (Hensher & Bullock, 1979) of 0.09 for car with respect to train fares is higher than the three estimates in Table 10.7 of 0.053, 0.042 and 0.003 (the first elasticity in row 1 of cells 1, 2 and 3 of the car row); likewise the combined bus and train estimate of 0.06 in Madan and Groenhout (1987) is only exceeded by 0.066 for the bus single ticket (column 4 of the car row), but a weighed average is significantly lower than 0.06. The evidence for the extant literature suggests that studies in the past based on methods possibly less rigorous than those applied herein, have tended to overestimate cross elasticities; however the great variation in estimates promotes caution in generalising too much. It does appear however that the previous estimates for Sydney commuters provided by Hensher and Bullock (1979), Madan and Groenhout (1987) are overestimates. The results from the RP stand alone model herein (the first value in row 2 of each cell), which are comparable to the data context of the earlier studies by Hensher and Bullock and Madan and Groenhout, provide contemporary support for this view, as do the RP-MNL results for the joint SP-RP model (first value in row 3 of each cell).

10.6. CONCLUSIONS

The results reported here are based on estimation of stated and revealed choice data where the variances of the unobserved components of the indirect utility expressions associated with each of the 7 ticket/mode alternatives are different. The taste weights attached to fares in the stated choice model have been rescaled by the ratio of the variances associated with fare for a particular alternative across the two model systems so that the richness of the fare data in the stated choice experiment enriches the market model. The resulting matrix of direct and cross elasticities reflects the market environment in which commuters make choices, while benefiting by an enhanced understanding of how travellers respond to fare profiles not always observed in real markets, but including fare profiles which are of interest as potential alternatives to the current market offerings.

A better understanding of market sensitivity to classes of tickets is promoted as part of the improvement in management practices designed to improve fare yields. In this paper we have examined a number of approaches to estimating a matrix of direct and cross price share elasticities, and provide for the first time a complete asymmetric matrix. The ITS has developed a DSS (titled 'Fares Fair') in which the matrix of elasticities are the behavioural base. Public transport operators in NSW are using the DSS to evaluate the implications on revenue and patronage of alternative fare scenarios in respect of mixture of ticket types and levels of fares. Extensions of the current paper are in progress which accommodate new ticket types and extend the empirical results to non-commuter markets, as well as adjust the choice elasticity matrix to obtain a matrix of ordinary demand elasticities, the latter following the adjustments made by Taplin et al. (1997) for commuter estimates.

CHAPTER 11

PRESERVING THE SYMMETRY OF ESTIMATED COMMUTER TRAVEL ELASTICITIES

11.1. INTRODUCTION

When analysts depended primarily on time series for price and travel data, it was difficult to estimate cross-price demand parameters for any type of travel, particularly urban travel where the evaluation set of market alternatives might include new alternatives and/or an extended set of attribute levels outside of the range observed in the market. This difficulty has been largely overcome by the fusion of revealed and stated choice data (Morikawa, 1989; Hensher, 2004). In addition, recent studies by Bhat (1995, 1996) and Hensher (1998b and Chapter 10) using a heteroscedastic extreme value (HEV) choice model have enriched the standard methods of deriving direct elasticities (i.e., multinomial and nested logit) to capture the behavioural richness required to produce estimates of cross choice elasticities, derived by the relaxation of the constant variance assumption of the random component of the indirect utility expression associated with each alternative. This method was used in the 1995 enquiry into transit fare levels and mixes for Sydney (Hensher & Raimond, 1996). The objective was to determine the sensitivity of Sydney residents to changes in public transport fares and to establish a full matrix of own and cross price elasticities for each transport mode and ticket type. To explore potential pricing policies, the ordinary demand elasticities are needed, but a test of the data shows that, in the commuter case, choice and ordinary elasticities are approximately equal.

It is well established theoretically and empirically that ordinary elasticities conform to the symmetry condition (Brown & Deaton, 1972; Barten, 1977). This is a matter of internal and mutual consistency between the fare elasticities. Reliable evaluations of urban transit policies, as discussed by Glaister and Lewis (1978) and DeBorger, Mayers, Proost, and Wouters (1996), can only be made on the basis of mutually consistent estimates of ordinary demand elasticities.

Symmetry holds for the individual choice estimates but, when these are aggregated to the population level in elasticity form, symmetry is unlikely to be preserved. Furthermore, the necessary property that probabilities with respect to a particular price sum to zero is not preserved in the resulting elasticities weighted by population shares. The natural response would be to change the estimation procedure so that these fundamental properties are preserved at the aggregate level. This is done in models of continuous choice, such as the Rotterdam (Theil, 1975) and Almost Ideal Demand System (AIDS) (Deaton & Muellbauer, 1980) where symmetry is preserved at the mean of the time series or cross-section data. However, there is no readily achievable way of imposing such an extraneous constraint on HEV discrete choice estimation because the elasticities are calculated at the individual choice level and aggregated. Nevertheless, reliably forecasting the impact of a policy decision to change a particular fare depends upon an internally consistent matrix of aggregate elasticities. The work reported in this chapter was undertaken to optimally adjust the elasticity matrix, estimated by combined revealed and stated choice methods, so that it satisfies the symmetry condition.

The chapter is organised as follows. We begin with a formalisation of the relationship between choice and ordinary demand elasticities, which is followed by a discussion of the essential constraints to which an elasticity matrix must conform. Next, we present the full matrix of corrected demand elasticities and the method required to optimise the departures from the derived empirical demand elasticities in order to meet the theoretical constraints. The empirical setting is briefly presented followed by the presentation of the matrices of choice and demand elasticities.

11.2. CHOICE AND ORDINARY ELASTICITIES

The relationship between an ordinary elasticity ε_{ij} and the corresponding choice elasticity m_{ij} is

$$\varepsilon_{ij} = m_{ij} + \frac{\partial Q}{\partial c_j}\frac{c_i}{Q} \tag{11.1}$$

where $(\partial Q/\partial Q)(c_j/Q) = \eta_j$ is the generation or second-stage elasticity (Taplin, 1982, 1997). The change in aggregate traffic volume ∂Q is in response to a change in trip cost ∂c_j on travel alternative j.

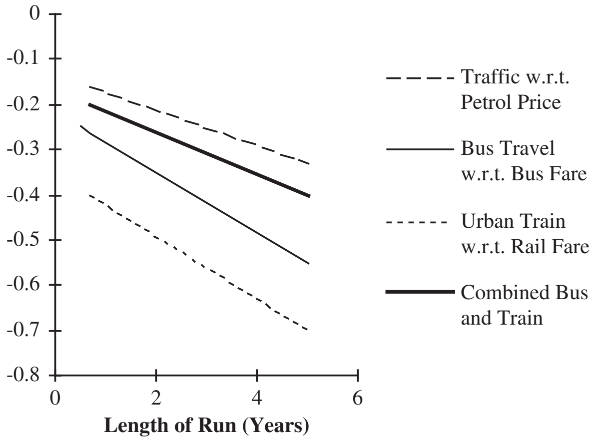


Fig. 11.1. Length of Run and Urban Travel Elasticities. *Source:* Goodwin (1992).

Table 11.1. Indicative Urban Travel Elasticities.

Travel Mode	Elasticity w.r.t. Fare or Cost of Trips by		Row Sum	Share Weight	Weighted Row Sum
	Public transport	Car			
Public Transport	−0.17	0.111	−0.059	0.35	−0.0207
Car	0.06	−0.13	−0.070	0.65	−0.0455
Indicative estimate of price (generation) elasticity of demand for urban travel					−0.0662

In the peak commuter case, any response to travel cost in the short run will be to switch fairly quickly between modes or ticket types. In the longer run, there may be more durable responses, such as changing residential location or work pattern, resulting in a change in the total amount of peak commuter travel. Such changes are reflected in the long-run generation elasticity. This chapter deals only with the short-run responses to fare or petrol price changes, an important question being whether there is any appreciable generation effect among peak commuters. Fig. 11.1 gives generalised representations of Goodwin's (1992) review findings, showing price elasticity becoming more elastic as travellers have more time to adjust.

Fig. 11.1 indicates that in the very short term, own-price urban travel elasticities for public transport and car are approximately as shown on the diagonal in Table 11.1. A number of estimates of the cross-elasticity of demand for car use with respect to public transport fares are available. One group is in the range 0.12 (McFadden, 1974) to 0.14 (Kraft & Domencich, 1972), another is 0.09 (Hensher & Bullock, 1979) and there are two at 0.06 (Glaister & Lewis, 1978; Madan & Groenhout, 1987). Taking the lowest of these with 65:35 mode shares, as in Sydney, symmetry gives the cross-elasticity of demand for public transport fares with respect to car trips of 0.111. A close approximation to the price elasticity of demand for urban peak travel as a whole, the generation elasticity, is the sum of the share weighted row sums, which is shown in Table 10.1 to be −0.066. Although small, it is probably an over-estimate because the Goodwin (1992) review includes some non-peak travel while the cross-elasticity is the lowest available estimate.

Even stronger evidence that there is no appreciable generation component in peak travel has been found by Hensher (1998b) who has shown, with the data used in this paper, that the hypothesis of no-income effect should be accepted ($t = 0.79$). This means no-generation effect because, under either weak or strong separability, generation would be due to an income effect.

It is concluded that, to the order of accuracy available with the estimates, the number of commuter trips is fixed in the short run, meaning that the aggregate traffic volume will remain constant regardless of a price variation for any mode or ticket type. This means that the generation elasticity is taken to be zero for all transport modes. This would not be true for non-commuter trips. In the commuter case, constant aggregate travel yields $m_{ij} - \varepsilon_{ij} = 0$, so that matrix **M** (the matrix of choice elasticities) and matrix **E** (the matrix of ordinary elasticities) are identical.

11.3. AGGREGATE DEMAND AND HEV PROPERTIES

The problem to be addressed is how to derive elasticity estimates at the aggregate level from the HEV discrete choice estimates.

11.3.1. Symmetry

In aggregate demand analysis, on the assumption of continuous substitution, basic symmetry is represented by the following equality (Green, 1976, p. 312), x_i and x_j being quantities consumed and c_i and c_j being the corresponding costs:

$$\left\lfloor \frac{\partial x_i}{\partial c_j} \right\rfloor_{\text{compensated}} = \left\lfloor \frac{\partial x_j}{\partial c_i} \right\rfloor_{\text{compensated}} \tag{11.2}$$

The "compensated" subscript indicates that notional income compensation keeps the household at a constant level of utility as price changes. In other words, the effect on income of the cost change (the Slutsky effect) is offset by a notional compensation payment or charge. Under this condition, a marginal increase in the cost of travel by mode A would have the same effect on travel by mode B as a marginal increase of the cost of travel on mode B would have on travel by mode A. The equality follows from the fact that the second derivatives in the utility maximisation are equal (Deaton & Muellbauer, 1980, p. 44; Theil, 1975, p. 3).[129]

The aggregate Slutsky relationship without compensated cross-price effects is obtained by adding an income compensating term to each side of (11.2):

$$\frac{\partial x_i}{\partial c_j} + x_j \frac{\partial x_j}{\partial Y} = \frac{\partial x_i}{\partial c_i} + \frac{\partial x_j}{\partial Y} \tag{11.3}$$

If ε_{ij} is elasticity of demand for x_i with respect to c_j and ε_{iy} is elasticity of demand for x_i with respect to income Y, the relationship becomes

$$\varepsilon_{ij} \frac{x_i}{c_j} + x_j \varepsilon_{iY} \frac{x_i}{Y} = \varepsilon_{ji} \frac{x_j}{c_i} + x_i \varepsilon_{jY} \frac{x_j}{Y} \tag{11.4}$$

Multiplying by $(Y/x_i x_j)$ and substituting shares of total expenditure, $(w_i = c_i x_i/Y)$ and $(w_i = c_j x_j/Y)$

$$\frac{1}{w_j} \varepsilon_{ij} + \varepsilon_{iY} = \frac{1}{w_i} \varepsilon_{ji} + \varepsilon_{jY}$$

$$\varepsilon_{ij} = \frac{w_j}{\vec{w}_i} \varepsilon_{ji} + w_i(\varepsilon_{iY} - \varepsilon_{iY}) \tag{11.5}$$

As already noted, a test has indicated that there is no significant income elasticity of demand for commuter travel, so that the second term on the right-hand side of (11.5) is dropped. The symmetry equation reflects consumers' consistency of preferences. Tests of the relationship have been influenced by model specification and have mainly been performed on complete consumer demand systems, often using the Rotterdam and AIDS models. Symmetry has been generally verified by such empirical tests

(Deaton & Muellbauer, 1980, p. 69; Blundell, 1988; Theil, 1975, p. 197) and prevails most clearly between close substitutes.

Such aggregate studies do not account for the range of prices across a service and across individuals. An aggregate demand model for bus travel does not usually differentiate between the services available within the mode by ticket type, location of travel and time of the day. Furthermore, it is often assumed that the representative service has a unique price applying to every individual riding on that mode. In reality, there is an array of services to meet individual needs and choices and each of these services has its own price.

Discrete choice models take advantage of the variety of trip attributes faced by consumers. Even with the coarsely graduated fares of public transit, there are many options. Added to this is the truly individual cost of service by the private car. To keep the experiment and sample to a manageable size, the public transport ticket categories have been collapsed to those most frequently used, while private vehicles have been modelled as one service. For each service, respondents faced personalised costs, which varied across the sample. However, as with aggregate studies, demand and revenue evaluation of pricing policies must still be based on a representative price for each service.

In the case of discrete choice estimates made with either the HEV or multinomial logit (MNL) models, the probabilities of individual q choosing modes i and j with respect to the utility of fares or costs of i and j are symmetric

$$\frac{\partial P_{iq}}{\partial V_{jq}} = \frac{\partial P_{jp}}{\partial V_{iq}} \tag{11.6}$$

The aggregate share elasticity is equal to the ordinary elasticity where no generation effect is assumed and is defined as the probability weighted average of individual elasticities (Ben-Akiva & Lerman, 1985, p. 112; Hensher & Johnson, 1981, p. 59). The partial derivative of the individual probability is written with respect to the systematic component of the individual's utility

$$\varepsilon_{ij} = m_{ij} = \frac{\beta_c \sum_q P_{iq}(\partial P_{iq}/\partial V_{jq})(c_{jq}/P_{iq})}{\sum_q P_{iq}} \tag{11.7}$$

$$\text{Let} \quad c_i = c_{iq} \;\; \forall q \quad \text{be a uniform cost of using service } i. \tag{11.8}$$

The symmetry requirement is

$$w_i \varepsilon_{ij} = w_j \varepsilon_{ji} \tag{11.9}$$

Under condition (11.8), the expected expenditure share for the aggregate commodity is

$$w_i = \frac{\sum_q P_{iq} c_i}{\sum_{j=1}^{J} \sum_q P_{jq} c_j} \tag{11.10}$$

At the individual level the probability derivatives are symmetrical (11.6). We intend to demonstrate, at the aggregate level and under the assumption of uniform costs for each service, the aggregate symmetry requirement (11.9) is satisfied. Taking the left-hand side of (11.9) we get

$$w_i \varepsilon_{ij} = \left(\frac{\sum_q P_{iq} c_i}{\sum_{k=1}^{J} \sum_q P_{kq} c_k} \right) \left(\frac{\beta_c \sum_q P_{iq} (\partial P_{iq} / \partial V_{jq})(c_j / P_{iq})}{\sum_q P_{iq}} \right)$$

$$= \left(\beta_c \frac{c_i c_j \sum_q (\partial P_{iq} / \partial V_{jq})}{\sum_{k=1}^{J} \sum_q P_{kq} c_k} \right)$$

By (11.6), the sum of the partial derivatives $(\partial P_{iq} / \partial V_{jq})$ corresponds to the sum of the partial derivatives $(\partial P_{jq} / \partial V_{iq})$

$$= \beta_c \frac{c_i c_j \sum_q (\partial P_{jp} / \partial V_{iq})}{\sum_{k=1}^{J} \sum_q P_{kq} c_k} \tag{11.11}$$

which is the right-hand side of (11.9).

Thus, symmetry at the aggregate level is an outcome of the choice modelling process if each elasticity is for a representative price for each service. This would be the case if the cost on each service were uniform across all users. However, achieving this would come at great cost in providing sufficient sample representatives for each category. Consequently, a degree of aggregation is accepted in classifying services.

The result is that estimates made with the HEV model at the individual choice level satisfy symmetry, but the symmetry is lost in aggregating to the population level. Although the population shares are used in the maximum likelihood estimation, the aggregate symmetry relationship is unlikely to be satisfied. It is not feasible to impose an extraneous constraint on the HEV discrete choice estimation to achieve aggregate symmetry because the elasticities are calculated at the individual choice level and aggregated. The post-estimation procedure used in this chapter seeks to retain, after aggregation across individual choices and costs, the symmetry imposed at the individual level by the HEV model.

11.3.2. Share Weighted Column Sum

At the individual level, the partial derivatives, with respect to the *j*th utility, of the probabilities P_{iq} that individual q will choose the *i*th mode add to zero. For the *J* mode/ticket types in the universal choice set

$$\sum_{i=1}^{J} \frac{\partial P_{iq}}{\partial V_{jq}} = 0 \qquad (11.12)$$

The individual direct and cross derivatives also sum to zero along each row, as well as down each column, but this paper is concerned with the column sum. At the aggregate level, in a complete matrix of choice elasticities, if s_i is the share of choices going to *i*,

$$\sum_{i=1}^{J} s_i m_{ij} = 0 \qquad (11.13)$$

This means that commuters diverted from the *i*th mode due to a rise in price *j* must transfer to the other modes.

The preservation of observed market shares is accounted for at the modelling stage by weighting utility functions for each alternative. The complexity of the HEV maximum Likelihood function, however, will not allow a reproduction of the exact market shares incorporated into the model. This is a disadvantage of an HEV over an MNL, where the latter can exactly reproduce observed shares even where choice-based sampling is used. Policy based on aggregate elasticities for modal share evaluation should be able to use reliable measures of current modal shares observed within the market. When the share weighted sum equality (11.13) does not hold, evaluation of pricing policies will incorrectly produce a generation effect on the total number of trips.

The method used in this paper to correct the loss of the summation property and symmetry, both inherent in the HEV discrete choice model, is post-estimation optimisation. A set of minimally adjusted elasticities is found to satisfy both the share weighted sum and symmetry conditions.

Two alternative methods of avoiding or correcting the problem were considered and rejected. The first would be to assign average costs to individuals for specified alternatives at the pre-estimation stage. This procedure would preserve both the closed nature of the choice problem (share weighted sum) and symmetry at the aggregate level. However, the choice set of travel alternatives is far too large to allow for even an approximate matching of everybody's actual situation. A reduced set devised by the analyst would seriously misrepresent travellers' real choices and the average cost assigned to each individual would, in most cases, deviate substantially from what is actually faced.

The second alternative would be to assign average costs to individuals at a post-estimation stage. The point elasticities would then be evaluated at the assigned representative price. This would mean marginal probabilities with respect to indirect utilities being evaluated at the real costs faced by the traveller followed by a contrived elasticity evaluation at the assigned representative price. This would give the following elasticity estimate:

$$\varepsilon_{ij} = \frac{\sum_q P_{iq}(\partial P_{iq}/\partial c_{jq})\bar{c}_j/P_{iq})}{\sum_q P_{iq}} \tag{11.14}$$

This alternative does not give symmetry and the adding up property for the observed market shares, but merely restores symmetry for the sample.

The post-estimation optimisation method used in this paper preserves both the zero generation condition (11.13) and symmetry (11.6) for the observed market shares. Thus, it gives elasticities appropriate to the context for which they will be used, with symmetry and the adding up property consistent with market shares. The second alternative has some similarity in that both methods would restore symmetry at the representative price of $1.55 for train single, for example. The method of this paper first calculates elasticities for each individual at the fare actually experienced and aggregates by conventional probability weighting before correcting for symmetry whereas the second alternative would calculate marginal expected individual shares (probabilities) for each individual's situation at the fare actually experienced but aggregate elasticities would be calculated at the representative price.

11.3.3. Gross Substitutes

Because some urban commuters use more than one mode on each work trip, there are some complementarities between modes of transport. For example, where a bus feeds to a railway station, a reduction in bus fare would tend to attract passengers to the train. In far more cases, however, bus and train are substitutes and commuters who have a choice will tend to change from train to bus if the bus fare is reduced. The same applies to substitution between ticket types. Similarly, car and public transport are complementary in the cases of park-and-ride and kiss-and-ride but cases in which car and public transport are substitutes are much more common. Thus, it is consistent with expectations that the coefficient estimated from the Sydney sample for out of pocket costs β_c is significantly less than zero ($t = -4.15$), resulting in negative own elasticities and positive cross elasticities. This means that the ticket types and the car also are gross substitutes, so that the cross-price elasticities are constrained to be non-negative:[130]

$$\varepsilon_{ij} \geq 0, \quad i \neq j, \quad \forall i, j \in J \tag{11.15}$$

11.4. THE MODEL

The constrained matrix of ordinary demand elasticities for commuters takes the following form:

$$\mathbf{E} = \begin{bmatrix} \varepsilon_{11} = \dfrac{1}{-s_1}\left(\sum\limits_{\substack{i=1\\ i\neq 1}}^{n} s_i\varepsilon_{i1}\right) + \eta_1 & \varepsilon_{12} = \dfrac{w_2}{w_1}\varepsilon_{21} + \eta_2 & \varepsilon_{13} = \dfrac{w_3}{w_1}\varepsilon_{31} + \eta_3 & \varepsilon_{1n} = \dfrac{w_n}{w_1}\varepsilon_{n1} + \eta_n \\ \varepsilon_{21} + \eta_1 & \varepsilon_{22} = \dfrac{1}{-s_2}\left(\sum\limits_{\substack{i=1\\ i\neq 2}}^{n} s_i\varepsilon_{i2}\right) + \eta_2 & \varepsilon_{23} = \dfrac{w_3}{w_2}\varepsilon_{32} + \eta_3 & \varepsilon_{2n} = \dfrac{w_n}{w_2}\varepsilon_{n2} + \eta_n \\ \varepsilon_{31} + \eta_1 & \varepsilon_{32} + \eta_2 & \varepsilon_{33} = \dfrac{1}{-s_3}\left(\sum\limits_{\substack{i=1\\ i\neq 3}}^{n} s_i\varepsilon_{i3}\right) + \eta_3 & 0 \\ \varepsilon_{n1} + \eta_1 & \varepsilon_{n2} + \eta_2 & \varepsilon_{n3} + \eta_3 & \varepsilon_{nn} = \dfrac{1}{-s_n}\left(\sum\limits_{\substack{i=1\\ i\neq n}}^{n} s_i\varepsilon_{in}\right) + \eta_n \end{bmatrix} \tag{11.16}$$

where s_i is the trip share of mode or fare type i,
w_i is the expenditure share of mode or fare type i,
$w_j/w_i\ \varepsilon_{ij}$ represents the symmetry effect,

$(1/-s_i)(\sum_{\substack{i=1\\i\neq 2}}^{n} s_i\varepsilon_{ii}) + \eta_i$ results from the share weighted column sum constraint,

the generation elasticity for column j, $\eta_j = 0$ for all j, and $\varepsilon_{ij} \geq 0$, $i \neq j$, $\forall i$, $j \in J$ acts as a bounded constraint.

Matrix **E** is a complete set of elasticities, which satisfy symmetry and have zero weighted column sums. An important feature of the matrix is that both trip shares (s_i) and expenditure shares (w_i) enter the calculations. This matrix is a set of ordinary demand elasticities conditioned by theoretical constraints, which are consistent with the basic symmetry and adding-up properties of the HEV model that have been partly lost in aggregating from the individual discrete-choice elasticities. In generating matrix **E** and so restoring these properties, the starting point is provided by the elasticities initially obtained by aggregation to form matrix **K**.

Each elasticity in **K** is derived from the same cost parameter, β_c, the variation in elasticities being due to observed attributes of the alternatives, the variability of the unobserved attributes and some captivity to alternatives. The HEV is modelled under the assumption of independently but non-identically distributed unobserved attributes. The full information MLE also estimates the standard deviations of alternative specific population distributions. This information allows us to weight the optimal adjustment process according to the reliability of estimates on population utility for each alternative. The model is

$$f = \text{Min}\left[\sum_{i=1}^{J}\sum_{j=1}^{J}\frac{(k_{ij}-\varepsilon_{ij})^2}{(sd)_i}\left|\sum_{i=1}^{J} s_i\varepsilon_{ij} = 0; \qquad w_i\varepsilon_{ij} = w_j\varepsilon_{ji}; \quad \varepsilon_{ij} \geq 0,\right.\right.$$
$$\left. i \neq j; \quad \forall i, j \in J\right] \tag{11.17}$$

where k_{ij} is the initial discrete choice estimate of the elasticity on mode i with respect to price on j, belonging to matrix $\mathbf{K} = \{k_{ij}\}$, and sd_i is the standard deviation of the unobserved attributes for the ith alternative.

The share weighted column sum and the symmetry conditions are entered as functionally dependent elements, meaning only the below diagonal elements of matrix **E** are directly adjusted in this procedure. Non-negativity provides a lower bound to the elements being adjusted. The function to be minimised is a convex polynomial set contained within the positive orthant, each altered element's squared coefficient being non-negative.[131] A Newton method was used to find the changes, which give the required minimum.

Convergence was tested by reversing the functional dependency between the elements above and below the diagonal and by using various starting values. Each specification converged, as expected, on the same set of values.

11.5. THE EMPIRICAL CONTEXT

In a survey of 324 Sydney commuters, each respondent was asked to reveal characteristics of their current transport behaviour, and state their preferred method of transport under a selection of price scenarios (Hensher & Raimond, 1996; Hensher, 1998b). Survey respondents were asked to think about the last trip they made, where they went, how they travelled, how much it cost etc., and then were asked to describe an alternative way of making that trip if their current mode was not available. The current behaviour provided the revealed preference (RP) data. The stated preference (SP) component of the survey involved a series of different pricing scenarios for current and alternative methods of travel. The choice set was determined exogenously based on the physical availability of each alternative (including the availability of a car as a driver or passenger) for the journey to work.

The choice of mode and ticket type is estimated using a mixture of RP and SP data. The RP data's strengths lie in reflecting the current state of market behaviour, whereas the SP data's strengths are that it mirrors a more robust and less restricted decision environment and presents a well-conditioned design matrix. RP data provides information on the current market equilibrium for the behaviour of interest and is useful for short-term forecasting of departures from the current equilibrium. In contrast, SP data are especially rich in attribute trade-off information, but is to some extent affected by the degree of 'contextual realism' that we can establish for the respondents (Hensher, 1994). In deriving estimates of elasticities, the set of choice probabilities must reflect observed market behaviour (i.e., market shares), and hence we use the RP model enriched by the parameter estimates produced from the SP data appropriately re-scaled for each alternative when transferred to the RP model.

In order to offer realistic scenarios to all respondents, there was a range of showcards with different modal combinations and different travel distances. They covered every combination of main mode (car, train and bus) with short trips (less than 15 min), medium trips (15–30 min) and long trips (over 30 min). Ticket prices were varied 50% above and below prevailing levels. An illustrative showcard is presented in Table 11.2. Each respondent was presented with four different scenarios and different respondents are presented with different combinations of scenarios.

Table 11.2. Illustrative Set of Show Cards for the SP Experiment 1: Bus or Train for a Short Trip. *You have told us that you could either use a Bus or a Train as the main form of transport to travel to the destination that we have discussed. If public transport fares changed and were priced as below, would you have used Bus or Train as the main form of transport for your trip? Which ticket type would you choose?*

Bus Fares	Train Fares
Single $0.60	Single $0.80
TravelTen $4.00	Off Peak Return $0.90
(10 single trips)	*(purchase after 9am)*
TravelPass $8.60	Weekly $6.80
(7 days bus/ferry)	*(7 days train only)*
TravelPass $10.00	TravelPass $10.00
(7 days bus/ferry/train)	*(7 days bus/ferry/train)*

A fractional factorial design was used, each respondent being presented with four scenarios. Different respondents were presented with different combinations of scenarios. Responses to the different scenarios were recorded in terms of which mode and which fare type would be used, these individual travel responses providing the data for the derivation of aggregate mode choice elasticities with respect to fare prices (see Hensher & Raimond, 1996; Hensher, 1998b, for more details.)

The Sydney commuter trip and expenditure shares needed to evaluate the revenue effects of pricing policies are shown in Table 11.3. These have been used in the post-estimation procedure.

11.6. RESULTS

The unadjusted matrix of own and cross elasticities were derived from an HEV model, given in Appendix 3 from Hensher (1998b). Table 11.4 shows the results of the adjustment process for the own-price elasticities. Some of the changes in elasticities are substantial. In the Train Weekly case, where the originally estimated elasticity is small in absolute value, the percentage change is large. There is also a large change in car elasticity.

The results indicate that cost sensitivity within the commuter rail and bus markets is greater for single tickets than for multiple-trip tickets, with the exception of train travel pass. The implication for fares policy is that some

Table 11.3. Sydney Commuters: Trip and Spending Shares by Mode and Fare Type.

	Trip Share %	Average Cost for One-Way Trip ($)	Spending Share %
Train single	3.9	1.64	3.1
Train weekly	11.7	2.46	14.1
Train travelpass (BFT)	2.0	1.28	1.2
Bus single	4.9	2.37	5.7
Bus travel ten	8.1	1.17	4.6
Bus travelpass (BFT)	4.5	1.94	4.3
Car	64.8	2.12	66.9
Total	100.0		100.0

Source: Trip shares: Hensher and Raimond (1996). Cost: Hensher (1998b).

Table 11.4. Deviations of Optimally Adjusted Own-Price Elasticities from Original Estimates: Sydney Commuters.

	Own-Price Elasticity			
	Original	Adjusted	Change	% Change
Train single	−0.218	−0.228	−0.010	−4.5
Train weekly	−0.093	−0.167	−0.074	−79.4
Train travelpass (BFT)	−0.196	−0.212	−0.016	−8.4
Bus single	−0.357	−0.340	0.017	4.7
Bus travel ten	−0.160	−0.131	0.029	18.2
Bus travelpass (BFT)	−0.098	−0.097	0.001	0.7
Car	−0.197	−0.094	0.103	52.1

increase in the price of multi-use tickets, especially in the bus market, offers higher revenue growth prospects for small losses of patronage than is the case for single tickets.

The complete original and adjusted matrices of own and cross-elasticities are shown in Appendix 11B. Although there have been some large percentage changes in cross-elasticities, because the original values were small, the differences in actual magnitude have more significance for forecasting the effects of fare changes. The largest decrease is in elasticity of demand for car with respect to the price of a Bus Single from 0.066 to 0.018. The largest increase is in Bus Single with respect to car cost from 0.116 to 0.212. The cross elasticity estimates suggest that there is more movement between train and bus in the single fare class (cross-elasticities of 0.037 and 0.066) than between fare classes within modes.

11.7. INDICATIVE COMPARISONS WITH OTHER ESTIMATES

In demand studies based on household consumption data, the level of aggregation is varied by forming composite commodities before estimation, as desired by the analyst (Green, 1976; Deaton & Muellbauer, 1980). This is not feasible in the present study, which was designed to analyse behaviour at the highly disaggregated level of ticket types. The only point of aggregating is to make indicative comparisons with previous estimates and to consider the broad relationships between whole modes. Elasticity for a compound alternative equals the sum of component alternative elasticities, weighted by the component shares of the compound alternative (McFadden, 1979). Thus, the fare-type elasticities are condensed into modal elasticities is as follows:

the own-price elasticity for train

$$\varepsilon^{TT} = \sum_{i \in T} \sum_{j \in T} S_i^T \varepsilon_{ij}$$

The cross-price elasticity for train with respect to bus fare $\varepsilon^{TB} = \sum_{i \in T} \sum_{j \in B} S_i^T \varepsilon_{ij}$. The cross-price elasticity for bus with respect to train fare $\varepsilon^{BT} = \sum_{i \in B} \sum_{j \in T} S_i^B \varepsilon_{ij}$ and so on, where the train and bus the weights are:

$$s_i^T = \left(s_i \middle/ \sum_i s_i \right)$$

where $i \in T$, the set of demand function for ticket types on the train mode and

$$\mathrm{s}_i^B = \left(s_i \middle/ \sum_i s_i \right)$$

where $i \in B$, the set of demand function for ticket types on the bus mode.

Similar weighted sums are calculated for all modal own-price and cross elasticities (Table 11.5). The resulting approximations can be applied to a uniform percentage fare change within a mode. The method preserves the theoretical properties of the elasticity matrix at all levels.

The calculated own-price elasticities for train and bus of −0.186 and −0.151 are appreciably less elastic than the London peak travel elasticities[132] of −0.30 and −0.35 estimated by Glaister and Lewis (1978) and our cross-elasticities between train and bus are also smaller. However, our

Table 11.5. Optimally Adjusted Commuter Elasticities Condensed to Modes.

Travel Mode	Elasticity w.r.t. Fare or Cost of Trips by		
	Train	Bus	Car
Train	−0.186	0.019	0.181
Bus	0.016	−0.151	0.166
Car	0.046	0.036	−0.094

Table 11.6. Commuter Elasticities Condensed to Public Transport and Car.

Travel Mode	Elasticity w.r.t. Fare or Cost of Trips by	
	Public Transport	Car
Public transport	−0.151	0.173
Car	0.082	−0.094

cross-elasticities with respect to car-operating cost (Table 11.5) of 0.181 for train and 0.166 for bus are larger than the Glaister and Lewis estimates of 0.056 and 0.025, indicating that pricing policies, which raise car-operating costs, may increase public transit revenue.

Cross-elasticities between train and bus (Table 11.5) are small, indicating that price is a minor factor in commuter mode choice and mode switching within the Sydney public transit system. The cross elasticities for car use with respect to public transit fares are marginally smaller than other reported elasticities, 0.09 for car use with respect to train fares Hensher and Bullock (1979) and 0.06 for car use with respect to bus fares Lewis (1977) for peak work trips.

A further step was to condense the public transport modes into one (Table 11.6). The resulting own-price elasticity of −0.151 can be compared to the transit elasticities in the range −0.09 to −0.52 recorded in a review of aggregate studies by Oum et al. (1992a, 1992b). Not all of those studies were for peak travel; commuters lie at the inelastic end of the range. The own price elasticity for the cost of a single car trip is comparable to the aggregate demand elasticities of −0.1 reported in Luk and Hepburn (1993) and −0.16 in Goodwin (1992).

11.8. CONCLUSIONS

In most cases, travel choice elasticity estimates are inadequate for analysing the effects of pricing policies. The travel generation responses, which are embodied in ordinary demand elasticities, are also needed. Consequently, choice elasticities alone are insufficient to forecast responses to price changes in non-commuter travel markets.

In the case of commuter travel, however, the evidence indicates that the number of trips is approximately fixed, at least in the short run, so that the only responses to a fare or price change are shifts between modes and ticket types. This means that there are virtually no generation elasticities and the choice elasticities are approximately the same as the ordinary elasticities. This was indicated by a test of the data in Sydney where a choice analysis was based on a survey of 324 commuters who were asked to reveal characteristics of their current transport behaviour and state their preferred method of transport under a selection of price scenarios. From the responses, a complete matrix of choice elasticities was derived for six ticket types used for trips by train and bus, as well as car trips.

Although the choice elasticities can be treated as approximations to the ordinary elasticities, the estimated matrix will be reliable for pricing policy analysis only if it conforms to the symmetry condition for ordinary demand systems. To achieve this, each upper diagonal element (cross-elasticity) of the matrix was expressed as a symmetric function of the corresponding lower diagonal element. Then, each own-price elasticity was expressed as an exact function of the cross-elasticities in its column, using the choice condition that the trip-weighted elasticities in each column sum to zero. The lower diagonal elements were then adjusted, using a Newton procedure, to minimise the sum of the squared deviations from each original value divided by the standard deviation of the alternative. In effect, all elements of the matrix were subject to change. A test showed that the cross-elasticities are non-negative, so that the modes and ticket types are gross substitutes.

The results include some substantial deviations of the elasticities in the adjusted symmetric matrix from the original values. Although most of the own-price elasticities do not change a great deal, the Train Weekly fare own-elasticity changed from −0.093 to −0.167 and car cost own price elasticity changed from −0.197 to −0.094. A number of the cross-elasticities have changed by large percentages because the original values were very small. The absolute magnitude of changes is of more interest, the largest decrease being in elasticity of demand for car with respect to the price of a Bus Single from 0.066 to 0.018. The largest increase is in Bus Single with respect to car cost from 0.116 to 0.212.

APPENDIX 11A. THE STATED CHOICE EXPERIMENT FARE CATEGORIES AND LEVELS

	Low Fare ($)	Current Fare ($)	High Fare ($)
Train: single (off peak return)			
Short	0.80 (0.90)	1.60 (1.80)	2.40 (2.60)
Medium	1.30 (1.40)	2.60 (2.80)	3.90 (4.20)
Long	1.80 (2.00)	3.60 (4.00)	5.40 (6.00)
Train: weekly			
Short	6.80	11.50	18.30
Medium	9.70	19.40	29.00
Long	13.20	26.00	40.00
Train: travelpass			
Short	10.00	20.00	30.00
Medium	14.00	28.00	42.00
Long	20.00	39.00	59.00
Bus: single			
Short	0.60	1.20	1.80
Medium	1.30	2.50	3.80
Long	2.00	3.90	5.90
Bus: travelten			
Short	4.00	8.00	12.00
Medium	8.00	16.00	24.00
Long	16.00	32.00	48.00
Bus:travelpass (bus/ferry)			
Short	8.60	17.10	26.00
Medium	11.70	23.00	35.00
Long	17.20	34.00	52.00
Bus: travelpass(bus/ferry/train)			
Short	10.00	20.00	30.00
Medium	14.00	28.00	42.00
Long	19.50	39.00	59.00

APPENDIX 11B. ORIGINAL AND ADJUSTED MATRICES OF COMMUTER DEMAND ELASTICITIES

Travel by mode and fare type	Elasticity of Demand with Respect to Fare or Travel Cost by						
	Train			Bus			Car
	Single	Weekly	Travel-pass (BFT)	Single	Travel ten	Travel-pass (BFT)	
Original							
Train single	**–0.218**	0.001	0.001	0.057	0.005	0.005	0.196
Weekly	0.001	**–0.093**	0.001	0.001	0.001	0.006	0.092
Travel pass (BFT)	0.001	0.001	**–0.196**	0.001	0.012	0.001	0.335
Bus single	0.067	0.001	0.001	**–0.357**	0.001	0.001	0.116
Travel ten	0.020	0.004	0.002	0.001	**–0.160**	0.001	0.121
Travel pass (BFT)	0.007	0.036	0.001	0.001	0.001	**–0.098**	0.020
Car	0.053	0.042	0.003	0.066	0.016	0.003	**–0.197**
Adjusted							
Train single	**–0.228**	0.000	0.000	0.066	0.010	0.000	0.217
Weekly	0.000	**–0.167**	0.000	0.000	0.000	0.003	0.141
Travel pass (BFT)	0.000	0.000	**–0.212**	0.000	0.004	0.000	0.344
Bus Single	0.037	0.000	0.000	**–0.340**	0.019	0.008	0.212
Travel ten	0.007	0.000	0.001	0.024	**–0.131**	0.011	0.193
Travel pass (BFT)	0.000	0.009	0.000	0.011	0.012	**–0.097**	0.066
Car	0.010	0.030	0.006	0.018	0.013	0.004	**–0.094**

APPENDIX 11C. HEV MODEL: JOINT ESTIMATION OF SP AND RP CHOICES

Attribute	Units	Alternative	SP Parameter Estimates	*t*-Value	RP Parameter Estimates	*t*-Value
One-way trip cost (or fare)	Dollars	All	−0.34966	−4.15	−0.34966	−4.15
Trip cost squared	Dollars	All	0.00365	0.79	0.00365	0.79
Door-to-door time	Minutes	Train	−0.01862	−4.44	−0.01862	−4.44
Door-to-door time	Minutes	Bus	−0.02659	−4.95	−0.02659	−4.95
Door-to-door time	Minutes	Car	−0.02517	−5.86	−0.02517	−5.86
Train single constant		Train	7.8198	3.84	8.7959	3.98
Train weekly constant		Train	8.2091	3.93	10.319	4.17
Train travel pass constant		Train	8.0665	3.90	9.2150	3.31
Bus single constant		Bus	8.3482	4.00	9.4006	4.13
Bus travel ten constant		Bus	8.2200	3.95	9.6701	4.08
Bus travel pass constant		Bus	8.1234	3.94	9.7870	3.34
Car constant		Car	–	–	–	–
Captive to train dummy		Train	1.0657	2.42	1.0657	2.42
Captive to bus dummy		Bus	1.4792	3.44	1.4792	3.44
Car availability dummy	1,0	Car	9.2935	4.09	9.2935	4.09

Scale parameters (standard deviations in parenthesis)					
Train single	Train	0.962 (1.3336)	3.58	1.515 (0.8467)	3.73
Train weekly	Train	0.527 (2.4358)	2.46	0.340 (3.7723)	1.33
Train travel pass	Train	0.559 (2.2941)	3.57	0.557 (2.3045)	1.11
Bus single	Bus	0.510 (2.5139)	3.14	0.307 (4.1828)	1.16
Bus travel ten	Bus	0.780 (1.6448)	3.51	0.353 (3.6309)	1.18
Bus travel pass	Bus	0.515 (2.4926)	3.01	0.615 (2.0844)	1.82
Car	Car	3.338 (0.3842)	4.25	1.283 (1.0000)	Fixed
Value of travel time savings					
Train	\$/hour	3.36			
Bus	\$/hour	4.75			
Car	\$/hour	4.60			
Sample size		1824			
Log-likelihood at convergence		−1547.64			
Pseudo r-squared		0.730			

Notes: (1) Value of travel time savings is calculated per one-way trip based on average number of one-way trips per ticket. (2) The scale parameter is derived from the standard deviation estimate, the latter being set equal to 1.0 for the car alternative in the SP choice set. Given that $\sigma_{iq}^2 = \pi^2/6\lambda^2$, it follows that λ will not be based on 1.0.

This page intentionally left blank

CHAPTER 12

TRESIS (TRANSPORT AND ENVIRONMENTAL STRATEGY IMPACT SIMULATOR): A CASE STUDY

12.1. INTRODUCTION

This chapter presents an integrated microsimulation urban passenger transport model system (TRESIS) for evaluating the impact of a large number of interrelated policy instruments on urban travel behaviour and the environment. The model system has four integrated modules defining household location and automobile choices, commuter workplace and commuting travel choices, non-commuting travel activity, and worker distributed work practices. The demand model system, estimated as a set of discrete and continuous choice models, is combined with a set of equilibrating criteria in each of the location, automobile and commuting markets to predict overall demand for passenger travel in various socio-economic segments, automobile classes and geographic locations. The current version has been developed to operate at a high level of aggregation for the Sydney region, comprising a 14-zone system, with a spider-web network, and is designed to explore the impacts of broad strategic directions. The model system is embedded within a decision support system to make it an attractive suite of tools for practitioners. We illustrate the usefulness of TRESIS to a major investment option in Northeast Sydney, to replace a bottleneck opening bridge with either bridge improvements together with improvements to a number of intersections on the roads serving the region, or several possible tunnel options, including different levels of tolls for the tunnels. The application of TRESIS to this case was considered a success, with the model providing useful outputs on the revenue implications of various alternative tolls, the impacts of the proposals on regional travel, and the likely effects on public-transport ridership. As an application of a strategic model, allowing rapid turn-around of results without detailed and extensive network coding, but with the impacts on home location and workplace being reflected in the model, TRESIS provided a comprehensive regional view of the likely outcomes of the alternatives.

12.2. DETAILED BACKGROUND TO TRESIS

The Transport and Environmental Strategic Impact Simulator (TRESIS) is a microsimulation package, developed at the Institute of Transport Studies (ITS). It is designed as a policy advisory tool to evaluate, at a strategic level, the impact of transport and non-transport policy instruments on urban passenger travel behaviour and the environment, with a wide range of performance indicators. As an integrated model (Wegener, 2003; Southworth, 1995; Waddell, 1998; Hunt & Abraham, 2003) TRESIS offers users the ability to analyse and evaluate a variety of land use, transport and environmental policy strategies or scenarios for urban areas. The behavioural engine of TRESIS encompasses key household, individual and vehicle-related decisions; in particular where a household chooses to locate (and the type of dwelling to live in), where the workers from that household will work, the household's number and type of vehicles and level of use by trip purpose, and the means of travel that will be used for household member trips by departure time. Also, within the package, the total levels of trip making and an origin–destination (O–D) matrix are estimated for each trip purpose, and the resulting trips are assigned to a strategic network. From this a range of economic and environmental impacts are estimated. In the following discussion, whenever TRESIS is referenced, the reference is to version 1.4 of the software, which is the one used in this application.

TRESIS replicates the behaviour of the different decision makers such as households and travel makers. The model allows testing of various scenarios associated with land use, transport, environmental policies and projects. The results of a base-case scenario are used as references to compare with those of the policies and projects to be tested. The system generates a number of performance indicators to evaluate these effects in terms of economic, social, environmental and energy impacts. Earlier versions of TRESIS (with a 1993 base year) were developed and applied to six Australian cities, namely Canberra, Sydney, Melbourne, Brisbane, Adelaide and Perth (Hensher et al., 1995). The latest version of TRESIS modified and enhanced (with a 1998 base year) examines strategic level policy options for the Sydney Metropolitan Area (Hensher & Ton, 2002).

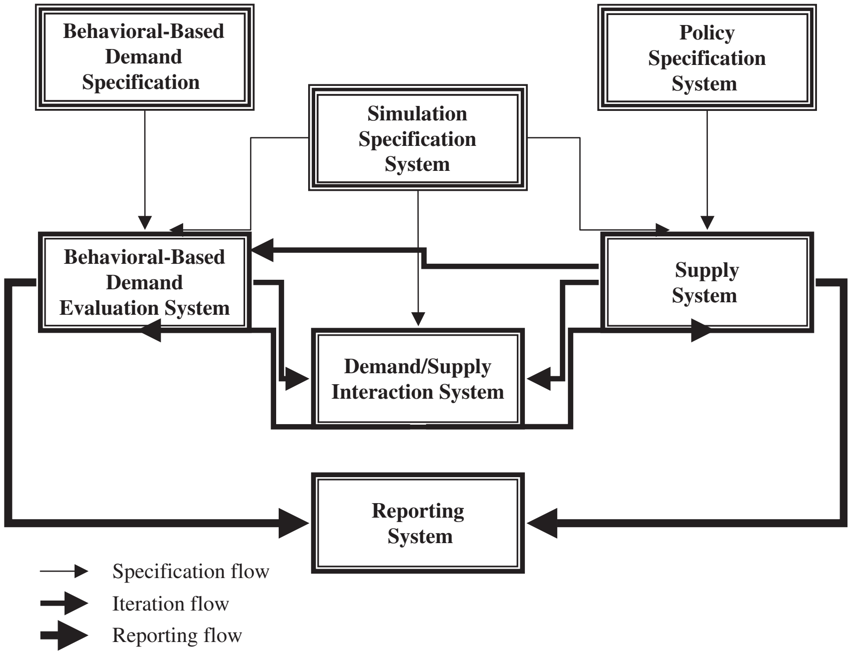


Fig. 12.1. TRESIS Structure.

TRESIS has a high-temporal resolution with an annual step-up to a 28-year forecasting horizon. It has full integration of land use and transport interaction in each simulation period. The highly synthetic nature of the model provides a detailed description of the base year of 1998 to be estimated within the model. TRESIS is structured around seven key systems (see Fig. 12.1). Each component is discussed in turn below.

Simulation specification system. This system provides a means for users of TRESIS to control (i) the types, sources and locations of input and output from TRESIS, (ii) the heuristic rule for accommodating the temporal adjustment process, (iii) the number of future years to be simulated from the present year and (iv) the specification to control the calibration and iteration process of TRESIS run. While all control factors are self explanatory, the heuristic rule for accommodating the temporal adjustment process needs to be clarified. The model system in TRESIS is static, and hence produces an instantaneous fully adjusted response to a policy application. In reality, choice responses take time to fully adjust, with the amount of time varying by specific decision. We expect that it would take longer for the full effect of the change in residential location to occur and much less time for departure time and even choice of transport mode. TRESIS allows users to impose a discount factor that establishes the amount of a change in choice probability that is likely to be taken up in the first year of a policy. It removes the rest of the change and uses the new one-year adjustment as the starting position for the next year. Intuitively, TRESIS is assuming that, if we had a fully dynamic choice model system, we would only observe the discounted impact after each year. Different discount factors would be specified to control the temporal process of change for different choice models in TRESIS.

Behavioural demand specification system. This system provides the household characteristics data and model formulation for the *behavioural demand evaluation* system of TRESIS. It contains a module for constructing a synthetic household database as well as a suite of utility expressions representing the behavioural system of choice models for individuals and households. These models are based on mixtures of revealed and SP data (Louviere et al., 2000; Hensher & Greene, 2001; Ton & Hensher, 2002): residential location choice, dwelling type choice, mode choice, trip timing, work place location, vehicle choice type, fleet size and automobile use by location (for more details see Hensher, 2002; Hensher, 1993a, 1993b, 1993c; McCarthy, 1995; McCarthy & Hensher, 1995, *inter alia*). Each synthetic household carries a weight that represents its contribution to the total population of households. Through time TRESIS carries forward the base year weights or, alternatively, modifies the weights to represent the changing composition of households in the population. More detailed information on the specification and procedure for the generation of synthetic households to represent population data is in Ton and Hensher.

Households adjust their residential locations in response to changes in the transport system and for other reasons. Consequently, any one of a number of strategies can influence the probability of a household both living in a particular location and the type of dwelling they choose to occupy. At any point in time there will be a total demand for dwelling types in each residential location. Excess demand will result in an increase in location rents and dwelling prices; excess supply will result in a reduction in the respective rents and prices. In TRESIS, dwelling prices are used to clear both the market for dwelling types and location, in the absence of data on location rents. The market clearing mechanism is linked into a set of impact indices, which 'allocate' heuristically the impact of a strategy on the choice of residential location and dwelling type across time so that, in the absence of a dynamically specified adjustment process within the behavioural-model set, the temporal response profile is 'realistic'. Equilibration is secured for both the dwelling type market and the residential location market. Disequilibrium is allowed for when an injection of new dwellings creates excess supply given the number of households. Under this strategy the simulator needs only to ensure that the demand for dwellings by type in a residential zone does not exceed supply for the zone. Any additional dwellings will be left vacant in the particular year as an indication that property developers may have created too much stock at that time. In future years as households grow the take-up rate increases without creating increases in dwelling prices until the market is cleared.

The utilities for individuals for the different choices come from the same model and, as such, the scaling parameter is unity. In the current version of TRESIS we treat each worker as an independent chooser of a workplace location. However when relating this worker model to a household residential location we added up the log sums for each worker.

Supply system. This system contains four key databases. They are (i) the transport network database (with different levels of service for each time of day for each of six main modes of transport including drive alone, ride share, train, bus, light rail and busway), (ii) the land-use zone database (with attributes such as number of different dwelling types and associated prices, number of jobs, etc.), (iii) Automobile technology or vehicle database (number of different vehicle types and associated performance and energy indicators) and (iv) the policy and environment parameters database (carbon contents in petrol, diesel, CNG and electric vehicles and others). Key attributes (such as travel times for different times of the day, demand level and associated prices of housing) of transport network and zone databases are updated dynamically at run time during the calibration process to reflect the impact of the demand system on the supply system. In return, the newly updated attributes of the *supply* system will have an impact on the *behavioural demand evaluation* system. The iterative control process is handled by the *demand/supply interaction* system.

Policy specification system. This is a key focus in the design of TRESIS. The richness of policy instruments is supported in TRESIS, such as new public transport, new toll roads, congestion pricing, gas guzzler or greenhouse gas taxes, changing residential densities, introducing designated bus lanes, implementing fare changes, altering parking policy, introducing more flexible-work practices and the introduction of more fuel-efficient vehicles. The policy specification system employs a graphical and map-based (Map Objects) user interface to translate a single or mixture of policy instruments into changes in the supply system.

Behavioural demand evaluation system. Given the input from the *behavioural demand specification* system and the *supply* system, the characteristics of each synthetic household are used to derive the full set of behavioural choice probabilities for the set of travel, location and vehicle choices and predictions of vehicle use.

Demand/supply interaction system. This system contains three key procedures to control or equilibrate the three different types of interactions between demand and supply. The key mechanism for driving these three procedures is the level of interaction between demand and supply. More detailed discussion of the underlying of these procedures is in Hensher and Ton (2002). The three procedures are briefly described as follows: (i) The equilibration in the residential location and dwelling-type market involves establishing total demand for different dwelling types in each residential location calculated at any point in time. Excess demand will result in an increase in location rents and dwelling prices. In TRESIS, prices for different dwelling types are used to clear the markets for dwelling types and locations, in the absence of data on location rents. (ii) For equilibration in the automobile market: a vehicle price relative model is used to determine the demand for new vehicles each year. This model controls the relativities of vehicle prices by vintage via given exogenous new vehicle prices. A vehicle scrappage model is used only to identify the loss of used vehicles consequent on vintage and used vehicle prices, where the latter are fixed by new vehicle prices in a given year. The supply of new vehicles is determined as the difference between the total household demand for vehicles and the supply of used vehicles after application of the scrappage model based on used vehicle prices. (iii) For equilibration in the travel market: households might adjust their route choices between origin and destination, or trip timing and/or mode choice in response to changes in the transport system, particularly the travel time and cost values between different origins and destinations. In other words, different households can have different choices in responding to changes in different levels of service at different times of the day.

TRESIS provides a comprehensive set of outputs (see Appendix 12A) representing performance indicators such as impacts on greenhouse gas emissions, accessibility, equity, air quality and household consumer surplus. The output is in the format of summary tables cross-tabulated by household types, household incomes and residential zones and in more detailed format by origin and destination (OD), by different times of day and by different simulation years. Table 12.1 summarises the richness of policies that can be evaluated including the attributes that can be assessed in a what-if scenario setting.

Table 12.1. Classification of Policy Instruments via Key Input Data in TRESIS.

Specific Policy	Attributes	Specific Location Application	Times of Day (TOD)
New/existing public transport	Frequency; travel time; fare; access; egress	Origin–destination	6
New/exiting roadway	Distance; capacity; auto travel time; congestion pricing; toll cost	Origin–destination	6
Parking charges	Dollars/h	Destination	6
Urban density	Three categories: houses; semi-detached; apartment/flat and associated prices	Origin	None
Carbon tax	Carbon tax (cents/kg)	Not location specific	None
GST on new vehicles	On new vehicle (from 2000)	Not location specific	None
Automobile technology	Mass (kg); whole sale price ($); acceleration (seconds to 100 km/h); fuel efficiency: city (l/100 km); highway (l/100 km)	Not location specific	None
Fuel excise by fuel type	Wholesale price of petrol (cents/L); excise component of price of petrol (cents/L); wholesale price of diesel (cents/L); excise component of price of diesel (cents/L)	Not location specific	None
Maximum ages of vehicles for scrapping high emitters	Maximum vintage to remove the high emitters from specific classes of vehicles (e.g., 16 years)	Not location specific	None
Vehicle registration charges	Dollars/year for different vehicle classes and types	Not location specific	None
Fuel efficiency of current fleet	Percentage of fuel efficiency of current fleet	Not location specific	None
Alternative fuels-CNG vehicles	Six Classes (from class 11 to class 16)	Not location specific	None
Price rebate/discounts on vehicles	Rebate on new vehicles	Not location specific	None

12.3. APPLICATION ISSUES

The behavioural choice and vehicle use models, together with the conditions for equilibration, define one part of an integrated model system. The application of the model system to evaluate a wide range of strategies and to derive useful empirical outputs requires a specification of a number of contextual dimensions. The following data inputs are required:

- population of households;
- population of automobiles (number by type);
- population of dwelling stock by location;
- population of employment opportunities (i.e., jobs) by location;
- attributes of automobiles;
- socioeconomic characteristics of individuals and households;
- network characteristics of each form of transport; and
- future time profile of exogenous variables in a status quo scenario (e.g., fuel prices, income, population growth, dwelling prices, public transport fares and service levels, new vehicle releases, automobile prices and attributes of new vehicles).

The sample of travellers and households used in model estimation is not used in model application. *Synthetic households* define the application units. There is a predefined number of such households in each city defined by core socioeconomic variables, e.g., the number of vehicles and lifecycle stage. A weight is attached to each synthetic household to indicate its incidence in the population. The set of socioeconomic characteristics that exist in the set of travel, vehicle and location models is broader than the core socioeconomic variables.

To ensure that the richness of the fuller set of socioeconomic variables contributing to the explanation of each choice are captured in the definition of synthetic households, so that the diversity of household responses is captured throughout the model system, one draws additional samples from each 'core' synthetic household. The approach involves taking a random sample of households from a global source, such as the one percent unit record sample of households, conditional on each core synthetic household. Because each of these households is a random sample from a 1% random sample, we would capture the distribution of household types within each core synthetic household type. The data associated with each of these sampled households must be sufficiently rich in socioeconomic characteristics of the household and its members. For example, the variables available from the 1% sample of the Census in Australia are: at the household level, household income, dwelling type, number of vehicles; at the person level, age, industry sector, hours worked, industry, occupation, labour force status, relationship in the household, income, sex, education qualifications and mode for the journey to work. Ton and Hensher provide full details on the derivation of particular synthetic households. We have evaluated the sensitivity of output indicators to differing numbers of synthetic households and found that a good number is in the 500–800 range. TRESIS can use any number of synthetic households up to 2000, chosen by the user at the calibration stage.

In application, each synthetic household is 'introduced' into an urban area, carrying only a bundle of socioeconomic descriptors for each household member and the household as a whole. Through the application of the behavioural model system and given the specification of the transport network, location attributes and automobile stock and attributes, the simulator calculates a full set of choice probabilities and vehicle use predictions associated with each of the alternatives in each of the travel, location and vehicle demand models. The probabilities and predictions of use are expanded for each synthetic household to represent the demand by all households in the population represented by a synthetic household. The calculations are repeated for each synthetic household and then equilibration in the three markets (travel, location and vehicle) is undertaken to arrive at a final set of *demand estimates.* The set of outputs are also accumulated throughout the simulator calculations so that a comparison can be made for each application year of each output before and after the simulation of one or more policy instruments that define a strategy.

Complementing the synthetic households are data specifications for new and used automobiles by class and fuel type, the transport network for existing and new modes, spatial and dwelling attributes for residential locations and employment attributes for workplace locations. Forecasting the set of exogenous factors through time relies on external benchmarks for population growth, household size growth, price changes for dwellings, fuel, vehicles, fares etc., and the release of new vehicles by type.

A base year for model development and implementation has to be selected (in the case study, we use 1998, with December the actual time point at which to measure all activities and external data such as vehicle registrations and population). The system has to be calibrated for the base year population profiles and then applied annually with summaries of outputs for each year over the range of specified years. Each of the behavioural models has to be calibrated to reproduce the base year shares and total on each

Table 12.2. Base Year Calibration Criteria.

Decision Block	Data Criterion
Location (per location)	• Dwelling type share • Total number of households • Total number of workers • Household fleet size distribution (0,1,2,3+)
Vehicle (per vehicle class)	• Vehicle class shares • Total registered passenger vehicles • Total passenger vehicle kilometres • Household fleet size composition
Travel	• Commuter mode share • Travel time (origin–destination) • Commuter departure time profile • Sample spatial and temporal work practice composition

alternative. Once the models are calibrated, the parameter set remains unchanged in all applications. New calibration is required when base input data are changed. The data items selected for calibration in the case study are shown in Table 12.2.

12.4. WARRINGAH CASE STUDY

In response to on-going traffic problems in the Warringah area, the Federal Bureau of Transport and Regional Economics (BTRE) commissioned ITS to assess the feasibility of a number of strategies for improving transport in the area. Two different tunnel options were considered, each with and without tolls, plus a do-nothing option. In the first stage of the project, ITS collected detailed travel time data on major traffic routes used to access Ku-ring-gai, Lower North Sydney and Inner Sydney from the Warringah area, using Global Positioning System (GPS) technology (Bullock et al., 2003). The travel time information gained was then used in TRESIS to evaluate the impact that each strategy would have on patterns of travel demand.

This section of the paper documents the second stage activities of the project, centred around the implementation of TRESIS version 1.4, in which we established baseline and options forecasts of travel demand for car and public transport modes over the period 2004–2025. It is assumed that the options are implemented by 2005, so 2004 represents the last year before the options are introduced. Values for 2002 are provided as a reference point to the present. Option A is two 2-lane tunnels from the Spit Bridge to the

Warringah Freeway, and involves the addition of a new bridge at the Spit, and a total tunnel length of 5.1 km. Option A1 is the same, but introduces a toll of $3.50 for the tunnels in each direction. Option B extends the tunnels to 7.6 km in length, and includes a tunnel underneath where Spit Bridge currently sits, with exits into the main arterial roadways about 2 km further northeast. Option B1 also introduces a $3.50 toll. The do nothing alternative assumes that no major works are undertaken in the area. The main results are summarised in Table 12.3.

From Table 12.3, it can be seen that the impacts of the alternatives are very small in overall terms. In general, differences in numbers of trips, VKM, bus trips and total user money costs are quite small. Exceptions to this are found in total trips, where the tolled options (A1 and B1) decrease total trip making by around 8,000 trips per day, which stays fairly constant over the following years; the total travel time, which falls by around 100 million hours per year (600 million minutes), or about 8% of the total; total annual travel time cost, which falls by around $150 million dollars per year, or about 8 percent; and toll revenues, which increase by about $35 million per year for the tolled tunnels.

12.4.1. Detailed Results

While the overall statistics for Warringah show relatively little change with the options, these overall statistics mask somewhat more interesting shifts that take place within the more detailed sub-regions of the Sydney region. It is important to understand that overall population, jobs and workers do not change across the options for the entire region, it being assumed that the effects of the project in Warringah will be to redistribute jobs, workers, residents and trips. As a result, there will be generally small shifts in numbers throughout the region as the result of the implementation of any project. The main issues of interest, however, are the effects on trips that originate anywhere in the region and find a destination in Warringah, and those that originate in Warringah and find a destination anywhere in the region. Table 12.4 shows that there are relatively small differences in total trip making as a result of the options. The untolled options start with a lower figure for total trips in 2005 and 2010, but then climb past the do nothing case, ending, however, only at an increase of about 1,000 trips per day. The tolled tunnels result in decreased total trips, probably as a result of the tolls. The decrease is about 10,000 trips by 2025, or about 1% of total trip making.

Table 12.3. Summary of Major Results for Each Option for the Warringah Region Using 2020 as a Reference Point.

Statistic	Do Nothing	Option A	Option A1	Option B	Option B1
Total trips	923,500	924,800	916,200	926,500	915,200
Commuting trips	176,500	176,700	176,600	176,700	176,600
Total travel time	9,074,000,000	8,481,000,000	8,448,000,000	8,432,000,000	8,382,000,000
Total annual travel time cost	$2,242,000,000	$2,111,000,000	$2,093,000,000	$2,099,000,000	$2,077,000,000
Total passenger vkm	2,481,000,000	2,494,000,000	2,490,000,000	2,495,000,000	2,491,000,000
Total toll revenues	$45,511,000	$50,484,000	$85,291,000	$51,038,000	$86,951,000
Daily bus trips	73,900	62,600	71,100	61,400	69,500
Total user money costs	$532,700,000	$537,600,000	$576,800,000	$538,300,000	$578,200,000

Table 12.4. Total Trips with an Origin or Destination in Warringah for Each Option.

Option	2002	2004	2005	2010	2015	2020	2025
Do nothing	777,800	800,300	807,000	845,000	883,700	923,500	967,000
A	777,800	800,300	805,400	843,800	886,600	924,800	968,800
A1	777,800	800,300	798,900	834,700	876,100	916,200	957,900
B	777,800	800,300	805,500	844,100	887,000	926,500	968,700
B1	777,800	800,300	799,200	835,200	877,900	915,200	958,900

Table 12.5. Number of Households in Warringah for Each Option.

Option	2002	2004	2005	2010	2015	2020	2025
Do nothing	92,500	94,300	95,300	100,100	105,200	110,600	116,200
A	92,500	94,300	95,600	100,500	105,600	111,000	116,600
A1	92,500	94,300	95,500	100,400	105,500	110,900	116,500
B	92,500	94,300	95,600	100,500	105,600	111,000	116,600
B1	92,500	94,300	95,500	100,400	105,500	110,900	116,500

Table 12.6. Number of Jobs in Warringah for Each Option.

Option	2002	2004	2005	2010	2015	2020	2025
Do nothing	74,600	76,000	76,800	80,600	84,500	88,700	93,000
A	74,600	76,000	78,200	82,400	86,500	90,900	95,400
A1	74,600	76,000	77,800	82,000	86,100	90,400	95,000
B	74,600	76,000	78,400	82,700	86,800	91,100	95,700
B1	74,600	76,000	78,000	82,200	86,300	90,600	95,200

Tables 12.5 and 12.6 show the numbers of households and jobs in Warringah, and show an expected relationship to Table 12.4. The effects of the option on households in Warringah are almost negligible. Differences are on the order of 200–400 households, or less than one half percent. There is a slightly greater impact on jobs in the region, with the tunnels apparently making it more attractive for employers to locate in Warringah. The overall increase in jobs under all tunnel options is about 2,000, and there is little difference between the tolled and untolled tunnels.

Table 12.7 shows the comparison of the five alternatives for the total trips with an origin in Warringah (zone 13) and a destination anywhere in the region for the years 2005 and 2025. (The trips with an origin anywhere in the

Table 12.7. Comparison of Total Trips with an Origin in Zone 13 and a Destination in Zones 1–14.

Option	Year	Destination Zone													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Do nothing	2005	39,800	8,100	8,800	7,800	6,300	4,400	6,100	12,200	6,800	11,600	65,500	30,800	590,100	8,800
	2025	48,700	9,800	10,900	9,600	7,800	5,400	7,500	15,100	8,500	14,600	79,600	38,600	700,000	11,000
A (no toll)	2005	40,900	8,500	9,200	8,000	6,500	4,500	6,700	12,500	6,800	11,600	68,600	30,600	582,300	8,800
	2025	50,900	10,700	11,400	10,000	8,200	5,600	8,400	15,600	8,400	14,400	85,900	38,300	690,000	10,900
A1	2005	41,300	8,600	9,200	8,100	6,600	4,500	6,800	12,500	6,800	11,600	58,600	30,700	584,800	8,800
	2025	51,500	10,800	11,600	10,200	8,300	5,600	8,500	15,700	8,500	14,500	70,500	38,400	692,700	11,000
B (no toll)	2005	41,100	8,600	9,200	8,100	6,500	4,500	6,700	12,500	6,800	11,600	69,300	30,500	581,400	8,800
	2025	51,100	10,800	11,500	10,100	8,200	5,600	8,400	15,600	8,500	14,500	86,900	38,300	688,500	10,900
B1	2005	41,500	8,700	9,300	8,100	6,600	4,500	6,800	12,600	6,800	11,700	59,300	30,600	584,000	8,800
	2025	51,800	10,900	11,600	10,200	8,300	5,700	8,600	15,800	8,500	14,600	71,700	38,400	691,900	11,000

region and a destination in Warringah is the transpose of each of these rows to a column, given the 24-hour symmetry of the trip table.)

As can be seen from the table, all of the options favour travel to and from the CBD (zone 1), compared to the do-nothing case. Within the options, there are only small differences in the trip numbers. All of the tunnel options reduce the number of trips that start and end within Warringah (zone 13). Travel to and from zones 5 (Fairfield-Liverpool), 6 (Outer South Western Sydney), 9 (Outer Western Sydney), 10 (Blacktown-Baulkham Hills) and 14 (Gosford-Wyong) is essentially unaffected by the options, while travel to and from zone 11 (Lower Northern Sydney) increases even more than to and from the CBD for the untolled tunnels, but decreases significantly for the tolled tunnels. These shifts are about what one would expect. It is important to note, however, that the total number of trips within the Northern Beaches area represent about 75% of the total trip making. Therefore, the trips moving into and out of the region are a small percentage of total trip making.

Table 12.8 shows the impact of the alternatives on total travel time for residents of Warringah. It can be seen that the tunnel options save significant amounts of travel time, especially alternative B1. The time savings result partly from a reduction in total trips and partly from increased speeds in the tunnels and on the competing surface roads.

Table 12.9 shows the expected annual total toll revenues for residents in Warringah. The Do Nothing case covers the tolls on all the other toll roads in the region. The increments under the tunnel options show both additional tolls paid on such facilities as the Harbour Bridge and Tunnel, and the M2, M4, etc., and A1 and B1 show the additional amounts that would be obtained from the new tolled tunnels across the Middle Harbour. From this table, one can see that toll revenues will increase by about $3 million per year to about $5 million per year on the other toll facilities of the region under option A, and from about $3.5 million per year to about $5.5 million

Table 12.8. Comparison of Total Travel Time for Warringah Residents (Millions of Minutes).

Option	2002	2004	2005	2010	2015	2020	2025
Do nothing	7,192	7,461	7,555	8,032	8,535	9,074	9,654
A	7,192	7,461	7,038	7,500	8,006	8,481	9,039
A1	7,192	7,461	7,022	7,465	7,957	8,448	8,975
B	7,192	7,461	6,984	7,441	7,943	8,432	8,960
B1	7,192	7,461	6,975	7,419	7,919	8,382	8,924

Table 12.9. Comparison of Total Annual Toll Revenues Paid by Warringah Residents ('000 dollars).

Option	2002	2004	2005	2010	2015	2020	2025
Do nothing	$38,111	$39,205	$39,521	$41,371	$43,378	$45,511	$47,818
A	$38,111	$39,205	$42,648	$45,555	$48,092	$50,484	$53,181
A1	$38,111	$39,205	$74,114	$76,918	$81,104	$85,291	$89,643
B	$38,111	$39,205	$42,983	$46,007	$48,576	$51,038	$53,657
B1	$38,111	$39,205	$75,315	$78,498	$82,904	$86,951	$91,612

per year under option B. However, the toll tunnels across Middle Harbour bring in a total toll revenue increase on the order of $35 million in 2005 to $42 million in 2025, although it is not possible to determine how much of those increases are paid on other toll facilities in the region.

Overall, the tunnel options do not improve the bus share of the market, because they represent additional roadway capacity in and out of the Northern Beaches area, and consequently result in an increase in car use. Even the imposition of an all-day toll of $3.50 in 2002 constant dollars does not result in an increase in public transport use. Rather, it has the effect of reducing the decline in the public transport market share in the region, but does not reverse it. Total trip making on a daily basis increases with the untolled tunnels, and decreases with the tolled tunnels. Both changes are on the order of one percent of trips. The tunnels leave the population of the Northern Beaches almost unchanged, but increase the number of jobs by about two percent, and the number of workers in the region by less than 1%.

While total travel is barely affected, there are shifts in travel, with more travel being made to the CBD. With the untolled tunnels, travel increases even more significantly to the Lower Northern Sydney area, while travel to this area decreases sharply under the toll options. However, total travel into and out of the Northern Beaches area comprises only about 25% of all travel made in the region.

As might be expected, total commuting time and travel-time costs are reduced by the tunnel alternatives. These reductions are on the order of 7–8%. However, passenger vehicle kilometres of travel increase by less than one half of a percent. Toll revenues under the two tunnel toll options appear to be quite significant, and increase even with the untolled tunnels, because of the increased use of other tolled facilities around Sydney.

Bus patronage is lower under all options than without the tunnels. The reductions in bus use are significantly greater for the untolled tunnels than tolled. The decline under the untolled options puts bus patronage from Warringah residents back to a level that would probably have been reached about 12 years earlier without the tunnels. With tolls imposed on the tunnels, the decrease in public transport patronage is about 2,000 bus riders per day.

12.5. CONCLUSIONS

TRESIS is an ongoing development with a number of new initiatives in progress. The major new developments include the replacement of the expansion of commuter trips to all trips with a suite of non-commuting mode, timing, destination and frequency models; the generalisation to an urban area's maximum number of traffic zones (e.g., 904 in Sydney), but with a capability to choose the number of zones in conjunction with the number of synthetic households (mindful of the exponential increase in memory and computational time in processing the baseline calibration as well as applications); a restructure of the TRESIS architecture to facilitate portability to different urban areas anywhere in the world; and new methods to aggregate or disaggregate networks as the number of traffic zones are changed. The gaps that are noted for future research in particular are a property market model for land and housing, a new vehicle release predictive model for automobiles and a choice model system to predict the demand for alternative distributive work practices (e.g., telecommuting, compressed work week). Like all integrated model systems there are weaknesses, however we believe that TRESIS offers the potential to be the most flexible of all currently available integrated land use, transport and environment packages with user-friendly input and output interfaces.

The application of TRESIS to the Warringah study was considered to be a success. The study required a strategic-level tool, where individual facility impacts were not of interest. It was rather intended to assess the overall feasibility of a tunnel to replace the bridge, and to assess the likely revenue generation of different levels of toll for the tunnel. The application satisfied these needs, without entailing a major set of runs of a conventional four-step modelling procedure. Most of the weaknesses of the model are also, in a sense, its strengths. In this current version, the model is highly aggregate, and therefore relies on rather broad specifications of the capacity and level of service of links between the 14 zones. This means that it requires exogenous input of the speeds and capacities of these links, and is not a model that will estimate the link-by-link changes in speeds and levels of service.

However, it does well at the strategic level in estimating the changes in overall travel times for the region, based on these aggregate connections. The model is also unable to provide information on what happens within a zone. With very large zones, this could be a problem for some types of local policies, which would not be appropriate to test with this version of TRESIS. However, the ongoing change to a 904-zone version for Sydney will permit more local policies to be tested.

The fact that TRESIS showed rather small overall impacts in transport performance and other indicators seems to the authors to be very realistic. There is a tendency for many more detailed models to over-predict the amount of change that will take place in a region as a result of a single relatively localised investment.

APPENDIX 12A. TRESIS 1.4 OUTPUTS

Output	Description	Units	Comments
TCO_2 (kg)	Total annual carbon dioxide	Kilograms (kg)	Car (includes all passenger automobiles – sedan, wagons, utes, panel vans, 4WD)
NO_x (kg)	Total annual nitrogen oxides	Kilograms (kg)	Car, based on 1.03 g/vkm
CO (kg)	Total annual carbon monoxide	Kilograms (kg)	Car, based on 1.08 g/vkm
NMVOC (kg)	Total annual	Kilograms (kg)	Car, based on 0.53 g/vkm
N_2O (kg)	Total annual nitrogen dioxide	Kilograms (kg)	Car, based on 0.01 g/vkm
CH_4 (kg)	Total annual chlorofluorocarbons	Kilograms (kg)	Car, based on 0.01 g/vkm
TEUC.MC ($98)	Total annual end-use money cost	Dollars ($)	All person trips, includes for car: operating cost, registration charges, annualised vehicle cost, parking, toll, congestion charge; for PT = fares
TEUCPV.MC ($98)	Total annual end-use money cost in present value terms	Dollars 98 ($98)	All person trips, 8% discount rate
TEUC.OC ($98)	Total annual end-use operating costs	Dollars 98 ($98)	All person trips, car operating cost plus public transport fares
TEUCPV.OC ($)	Total annual end-use operating costs in present value terms	Dollars 98 ($98)	All person trips, car operating cost plus public transport fares
TEUC.TTC ($98)	Total annual end-use travel time cost	Dollars ($)	All person trips; with travel time for ride-share for each person in car (converted to dollars). Tu: check for PT it includes all components of time

APPENDIX 12A. (*Continued*)

Output	Description	Units	Comments
TEUCPV.TTC ($)	Total end-use travel time cost in present value terms	Dollars 98 ($98)	All person trips; with travel time for ride-share for each person in car (converted to dollars). Tu: check for PT it includes all components of time
TEUC.Time (min)	Total annual end-use travel time	Minutes (min)	All person trips; with travel time for ride-share for each person in car. Tu: check for PT it includes all components of time
TEMUDTMC ($98)	Total annual expected maximum utility from each model system for each of the model components defined-by the mode choice (CMC) links	Dollars ($)	Replace TEMUCMC with this and Tu to recalculate using full set of 36 exp V functions, etc.
TEMURLC ($98)	Total annual expected maximum utility from each model system for each of the model components defined-by the linkage: residential location choice (RLC) links	Dollars ($)	
ACCDTMC (Utility units)	Accessibility indicators-by departure time and mode choice (DTMC) links.	Utility units	

ACCRLC (Utility units)	Accessibility indicators – by the linkage: residential location choice (RLC) links	Utility units	
TVKM (km)	Total annual passenger vehicle kilometres	Kilometres (km)	Car
TVKMTwAw (km)	Total annual passenger vehicle kilometres: to/from work and as part of work	Kilometres (km)	Car
TVKMOU (km)	Total annual passenger vehicle kilometres: other urban	Kilometres (km)	Car
TVKMNonU (km)	Total annual passenger vehicle kilometres: non-urban	Kilometres (km)	Car
AvOpCost (cents/km)	Average operating cost of autos	cents/kilometre	Car
VehAnnCost ($98)	Annualised automobile capital cost	Dollars ($)	Car, 15 years at 8% real rate of interest, 11.68% amortisation factor per annum, on 85.5% of value (15% residual value)
VehOpCost ($98)	Total annual auto operating cost	Dollars ($)	Car. Fuel prices assumed to increase by 0.05% per annum
Tvehicles (number)	Total passenger vehicles	Number	Cars
Tenergy (L)	Total energy consumed by passenger vehicles	Liters	Car (petrol and diesel)
TgovtVehReg ($98)	Total government revenue from auto ownership	Dollars ($)	Car
TgovtExcise ($98)	Total government revenue from fuel excise	Dollars ($)	Car (petrol and diesel)
TgovtCarbT ($98)	Total government revenue from carbon tax	Dollars ($)	Car (petrol and diesel)

APPENDIX 12A. (*Continued*)

Output	Description	Units	Comments
TgovtSalesT ($98)	Total government revenue from sales tax (GST post-2000)	Dollars ($)	Car (petrol and diesel)
TtollRev ($98)	Total revenue from toll roads	Dollars ($)	Car
Tpark ($98)	Total revenue from parking strategy	Dollars ($)	Tpark ($) Car
TRCong ($98)	Total revenue from congestion pricing	Dollars ($)	Car
TPT ($98)	Total revenue from public transport use	Dollars ($)	All PT (all modes, private and public). Fares assumed to remain at $98 levels over 1999–2017
TGVehPurCost ($98)	Total government revenue from vehicle purchase cost	Dollars ($)	Car
TvehMaxAgeValue ($98)	Total cost of vehicle maximum age buyout	Dollars ($)	Car
TGVehRebCost ($98)	Total government vehicle rebate cost	Dollars ($)	Car
THhld (number)	Total number of households	Number	Growing at 1% per annum
Tpop (number)	Total number of people resident in each city	Number	Growing at 1% per annum
TwrkrRes (number)	Total number of workers (p/t and f/t) in each residential location	Number	Growing at 1% per annum
TwrkrWork (number)	Total number of workers (p/t and f/t) in each workplace	Number	Growing at 1% per annum

TDA (proportion)	Modal share for car drive alone mode share	Proportion	All person trips
TRS (proportion)	Modal share for ride share	Proportion	All person trips
Ttrain (proportion)	Modal share for train travel	Proportion	All person trips
Tbus (proportion)	Modal share for bus travel	Proportion	All person trips
TLrl (proportion)	Modal share for light rail travel	Proportion	All person trips
Tbwy (proportion)	Modal share for busway use	Proportion	All person trips
TDA (PA) (number)	Total number of annual car drive alone trips	Number	All person trips
TRS (PA) (number)	Total number of annual car ride share trips	Number	All person trips
Ttrain (PA) (number)	Total number of annual train trips	Number	All person trips
Tbus (PA) (number)	Total number of annual bus trips	Number	All person trips
TLrl (PA) (number)	Total number of annual light rail trips	Number	All person trips
Tbwy (PA) (number)	Total number of annual busway trips	Number	All person trips
Class01micro	Vehicle class proportion class 1	Proportion	Cars
Class02small	Vehicle class proportion class 2	Proportion	Cars
Class03med	Vehicle class proportion class 3	Proportion	Cars
Class04upmed1	Vehicle class proportion class 4	Proportion	Cars
Class05upmed2	Vehicle class proportion class 5	Proportion	Cars
Class06large	Vehicle class proportion class 6	Proportion	Cars
Class07lux	Vehicle class proportion class 7	Proportion	Cars
Class08lcom	Vehicle class proportion class 8	Proportion	Cars
Class094WD	Vehicle class proportion class 9	Proportion	Cars
Class10ltruck	Vehicle class proportion class 10	Proportion	Cars
Class11EVsm	Vehicle class proportion class 11	Proportion	Cars

APPENDIX 12A. (*Continued*)

Output	Description	Units	Comments
Class12EVmed	Vehicle class proportion class 12	Proportion	Cars
Class13EVlge	Vehicle class proportion class 13	Proportion	Cars
Class14AFsm	Vehicle class proportion class 14	Proportion	Cars
Class15AFmed	Vehicle class proportion class 15	Proportion	Cars
Class16AFlge	Vehicle class proportion class 16	Proportion	Cars
RVKMPCar	Vehicle kilometres per vehicle	Vkm/Car	Cars
RVKMPVehicle	Vehicle kilometres per vehicle	Vkm/vehicle	DELETE
RVehiclePHhld	Vehicle per household	Vehicle/ household	Cars
RC0$_2$PVKM	CO_2/vkm	CO_2/vkm	Cars
REnergyP100VKM	Energy per 100 vehicle kilometres	Litres/100 km	Cars
RVehPCapita	Vehicle per capita	Vehicle/capita	Cars
RGCPersT ($98)	Generalised cost per person trip for car	$/car person trip	Cars, includes travel time (converted to dollars) and all money costs
RGCOPers ($98)	Generalised cost per person trip for car	$/car person trip	Cars, includes travel time (converted to dollars) and only car op cost
RGCPubT ($98)	Generalised cost per person trip for PT	$/PT person trip	All modes of public transport, fares plus travel time (converted to dollars)

RTEUGCPersT ($98)	Total end use generalised cost per person trip	$/person trip	Sum of TEUC.OC plus TEUC.TC ($98)
REMUDTMCPersT ($98)	Departure time and mode choice consumer surplus per person trip	$/person trip	
REMURLCPersT ($98)	Residential location (total) consumer surplus per person trip	$/person trip	
CmcAll (all trip matrices)	Number of all trips by mode	Number	
CmcCom (commuting to and from work trip matrices)	Number of commuting trips by mode	Number	

Note: A trip = A Person Trip (e.g., 2 persons ride sharing = 2 person trips).

This page intentionally left blank

CHAPTER 13

PRODUCTIVITY MEASUREMENT IN THE URBAN BUS SECTOR

13.1. INTRODUCTION

Performance measurement and benchmarking is a popular activity of government and non-government organisations in the transport sector. Where competition is absent, because of the presence of a natural monopoly or for whatever reason, yardstick competition is relying increasingly on performance indicators to establish best practise and to set targets. The literature on performance measurement is extensive and varies from very superficial studies emphasising arbitrary univariate indicators, which are subject to self-selection for inclusion/exclusion to suit the objectives of a particular organisation, to more comprehensive studies that identify global measures of performance and their disaggregated components. The better studies identify sources of variation between organisations so that management at various levels has some indication of the possible strategies to implement to improve an organisation's relative positioning.

Performance has many dimensions. In broad terms we distinguish between efficiency and effectiveness (Fig. 13.1). The efficiency of an enterprise represents the manner in which the physical inputs of labour, energy, maintenance materials, capital and overheads are used to produce the physical (intermediate) services defined by vehicle kilometres of service. Effectiveness has two essential components: (i) cost effectiveness – the relationship between inputs and consumed services (i.e., patronage levels) and (ii) service effectiveness – the relationship between produced services (i.e., vehicle kilometres) and consumed services (i.e., patronage levels). All of these global measures are *relative* measures of different dimensions of performance.

This chapter studies the cost efficiency and cost effectiveness of private and public bus operators in urban Australia, the dominant mover of people by public transport, carrying over 800 million passengers per annum (Hensher & Raimond, 1993). Service effectiveness, not considered herein, will have to be weighed against cost efficiency and cost effectiveness in a final

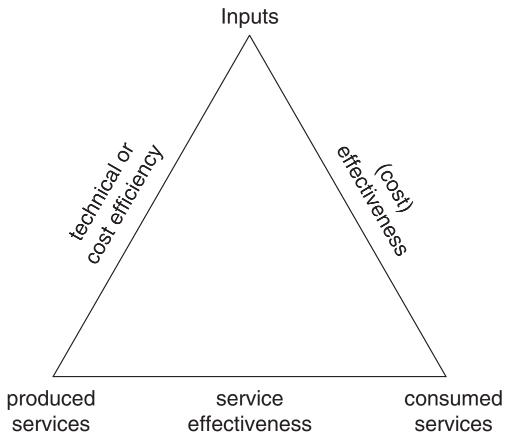


Fig. 13.1. The Essential Dimensions of Performance Measurement.

judgement on the global performance of each operator. Each capital city has a government bus operator primarily servicing the middle-to-inner suburbs and occasionally the outer suburbs (e.g., Transperth and ACTION). In most capital cities a private bus industry operates services in the middle-to-outer suburbs. In some cities (e.g., Perth), the private sector provides school services only. There are no private operators in Canberra. The private bus industry is a major player in Sydney, Brisbane and Melbourne, providing the full range of services: scheduled route services, scheduled school services, permanent school contracts, charter/tours and hire and drive.

In establishing a quantitative measure of the overall relative productivity of bus operators, it is also important to identify the influences, which contribute to explain the differences in overall productivity. Within the industry as a whole there are wide variations in the productivity with which services are provided. These include institutional differences such as ownership, subsidy arrangements and service delivery conditions, as well as contextual differences such as the size of the patronage catchment area, fleet utilisation and work practices. Knowing the extent to which sources of difference are under the control of the operator or are the consequence of uncontrollable external factors is important in identifying strategies by the operator and government/regulators, which are commensurate with improving productivity.

A single index that represents either cost efficiency (TFPvkm) or cost effectiveness (TFPpass) is total factor productivity (TFP). The reporting of both cost measures of performance is important. The cost efficiency measure is of particular interest to the operator because it relates to service levels to a large extent under their control, given patronage levels. Government regulators are also interested in how cost effective each operator is in moving passengers, the latter representing the prime purpose for being in business. Note that both measures must be interpreted at a strategic firm-wide level.

This chapter is organised as follows. We begin with a brief overview of the concept of TFP in the broader context of performance measurement. This is followed by a discussion of data requirements and the sourcing of suitable data. A descriptive profile of the sample is given as a precursor to development of the gross TFP (GTFP) indices for each operator. The GTFP index for each operator together with the partial productivity indices for labour, energy, capital, maintenance and other inputs are reported and regression-based analysis is undertaken to decompose the gross measure in order to establish the role of institutional and regulatory influences on relative productivity. Comparative analyses are undertaken within each of the private and public operator sectors and across all operations.

13.2. MEASURING PERFORMANCE – TOTAL FACTOR PRODUCTIVITY

Excluding measures of service effectiveness, there are two broad quantitative approaches to performance measurement:

- use of *financial* measures such as profitability or rates of return; and
- *productivity* measures (ratings of output production relative to input use).

Although widely used in the private sector, *financial measures* can be misleading indicators of economic or social performance. Profitability can be influenced by market power, e.g., monopolistic enterprises might be able to make substantial profits even if they were inefficient, whereas substantial competition may limit profitability even if individual firms' productivity is high. In the case of government enterprises, financial measures may be inappropriate because of restraints on pricing freedom and/or possible imposed unremunerative obligations. Some government services might not be charged for at all.

For both private and public enterprises, *productivity measures* generally are regarded as a more reliable indicator of performance in respect to cost efficiency and cost effectiveness. The basic notion of productivity is that of being able to supply more outputs from the same or fewer inputs. When multiple inputs and outputs are involved, it is possible to construct a variety of *performance ratios*, which compare one or more outputs to one or more inputs (for example labour cost per vehicle kilometre). However, these partial productivity measures have evident shortcomings in that they are incomplete measures of performance. The concept of TFP embraces a multiplicity of outputs and inputs, and thus can give a 'total' indication of productivity performance.

An index number measure of TFP can be constructed directly from data without the need for statistical estimation of a production or cost function. The index number approach requires data on output and input categories, as well as their respective prices (prices are the weights applicable to the quantities of outputs and inputs). The ratio of the output index to the input index is the calculated measure of TFP. A theoretically attractive index which has been widely adopted is the translog multi-lateral productivity index (TMPI) originally proposed by Caves, Christensen, and Diewert (1982). It can be used to undertake comparisons

(i) between organisations at a point in time (a cross-section), and/or
(ii) within an organisation over time (a time series), and/or
(iii) throughout the combined cross-section and time series.

The formal definition of the index is given below.

$$
\begin{aligned}
\frac{\mathrm{TFP}_k}{\mathrm{TFP}_b} = {} & \frac{1}{2}\sum_i (R_{ki} + \overline{R_i})(\ln Y_{ki} - \overline{Y_i}) - \frac{1}{2}\sum_i (R_{bi} + \overline{R_i})(\ln Y_{bi} - \overline{\ln Y_i}) \\
& - \frac{1}{2}\sum_i (W_{kn} + \overline{W_n})(\ln X_{kn} - \overline{X_n}) \\
& + \frac{1}{2}\sum_n (W_{bn} + \overline{W_n})(\ln X_{bn} - \overline{\ln X_n}) \qquad (13.1)
\end{aligned}
$$

where k is each individual observation $k = 1, \ldots, K$; b the base observation (a particular or average observation); i the outputs, $i = 1, \ldots, I$; n the inputs, $n = 1, \ldots, N$; R_i the weights for each output; $\overline{R_i}$ the arithmetic mean of output weights over all firms and years; W_n the weights for each input; $\overline{W_n}$ the arithmetic mean of input weights over all firms and years; $\ln\ Y_i$ the unit measure of output; $\overline{\ln Y_i}$ the geometric mean of unit measure over all firms and years; $\ln\ X_n$ the unit measure of input; and $\overline{\ln X_i}$ is the geometric mean of unit measure over all firms and years.

The output weights are revenue shares, and the input weights are cost shares. An important feature of an index number is that it should be invariant to the selection of the base year. The TMPI formula enables any pairwise comparison of two firms in one year or years within a business, and displays *characteristicity*, which means that the weights enable symmetric treatment of all firms and/or time periods, so that a comparison throughout a cross-section or panel of data is possible. A comparison between entities, which are independent of the organisation or year chosen as the base gives an index appeal in benchmarking.

The revenue-weighted TFP index is a *gross* measure of productivity (renamed in Hensher et al., 1992 as GTFP). It does not distinguish among sources of relative productivity. Thus, GTFP includes efficiency and/or effectiveness gains that come about as a result of exploitation of scale economies and/or other influences on production and costs, as well as gains due to true shifts in knowledge or our technical ability to produce things (Oum et al., 1992a, 1992b). Adopting some parametric (statistical) analysis, it is possible to identify the sources of variation in GTFP across organisations and/or over time. This is achieved by regressing GTFP on variables representing sources of variation. Examples might include output levels (to identify the influence of scale economies), exogenous market characteristics (e.g., favourable terrain for a transport company), work practices, network design predetermined by government to satisfy community-service obligations, and management practices. This *decomposition* of GTFP separates out variations in GTFP explainable by these variables.

13.3. DATA REQUIREMENTS AND THE SOURCING OF DATA

The range of data required to quantify performance in the urban bus sector is not readily available from any regular and/or publicly available sources. Private bus operators do not keep records of costs and revenues back through time, which is of sufficient detail to be useful. The Volvo Research Grant (Hensher, 1989) was the most recent comprehensive survey of private operators. The Annual Reports of all public bus operators are very incomplete as a source of suitable statistics. Furthermore, with few exceptions, operators tend not to keep the full range of data in a form that is easy to access.

In designing a survey instrument for completion by both public and private operators, we reviewed all previous empirical studies on bus productivity. From this review we consolidated the essential data requirements, taking into account the importance of each data item and the difficulties that operators have in providing certain items of information. Even after reducing the data requirements to the minimum required, it was determined that private operators would be unable to provide full information for previous financial years, but that a few items may be able to be supplied. With experience in the past in compiling suitable data, we decided to seek full information from all operators for the financial year 1 July 1991 to 30 June 1992.

13.3.1. Sourcing the Data

A total of 24 private operations in Brisbane, Sydney and Melbourne were selected, based on two criteria: a spread of sizes and geographical location within an urban area. All eight public operators in Australia participated.

13.3.2. State Differences in Private Bus Operations

Some distinguishing features of private operations between States are summarised below:

New South Wales

1. Minimum service levels and maximum fares for local scheduled route services, under the 1990 Passenger Transport Act.
2. No direct operator or capital cost subsidy.
3. Reimbursements for schoolchildren transport (SSTS) based on the number of issued passes which are determined by the number of children living in a particular service area.

Queensland

1. Operator subsidy: concessional reimbursement of 30% on average of gross-fare revenue, going up to 40%, based on performance, unless a profit ceiling is reached, whereupon the subsidy is reduced by up to 10%. This 10% adjustment acts as a disincentive to profitability. This profitability-related restriction on subsidy may encourage operators to overstate their true costs.
2. Subsidy to support interest on purchase and lease payments on vehicles; approximately 6%. The interest subsidy scheme will tend to encourage higher gearing levels.
3. Coaches (in contrast to buses) often used on local services.
4. School travel reimbursement paid through the Department of Transport on behalf of the Department of Education. There are two types of school transport reimbursements.

(i) For the pure school service under contract, it is cost based in accordance with the passenger capacity of a vehicle within a set of ranges. Industry-accepted unit running costs are used to calculate the reimbursement, given the total kilometres of service provided. A fixed-cost component is allowed.
(ii) Licensed school service provider where the eligible children are determined from returns from schools and operators. The reimbursement is on a per head basis less 10% to allow for absenteeism, sickness, school camps, etc.

Victoria

1. Cost contracts with Victorian Government.
2. All revenue handed over to the Government.
3. Casual employees are more costly than in NSW and Queensland.

All private and public operators are exempt from sales tax on the purchase of vehicles; however, other taxes such as sales tax on spare parts are not payable by public operators in contrast to private operations.

13.3.3. Subsidies

Each State has a different set of subsidy and reimbursement arrangements. In Brisbane, school and technical student reimbursements are for free travel only, with permanent school contracts being funded on a per km basis. In addition there is an operating subsidy for non-economic services as well as subsidy support for the interest associated with bus financing. Sydney operators do not receive any operating subsidy. Sydney operators receive a reimbursement for carrying schoolchildren under SSTS, which is based on school child eligibility, in contrast to Brisbane school transport, which is a mixture of cost-based and eligibility-based criteria (as described above). Melbourne operators are on a cost-only contract with all revenue attributable to the Government.

13.3.4. Use of Coaches and Buses

Many Brisbane operators use their coaches on scheduled route services, in contrast to the Sydney and Melbourne operators who almost never use coaches for such services. This increases service cost in Brisbane. Because of the sizeable mixing of buses and coaches in Brisbane, the questions on passenger levels asked in the survey were redefined to distinguish the carrying of schoolchildren, all other people on non-charter/tours and passengers on charters and tours. The distinction between patronage on type of vehicle is less important than the distinction between type of patronage. By asking the patronage question in terms of vehicle type, especially the patronage using a coach, while at the same time equating bus services to the carriage of schoolchildren and adults on scheduled-route services, we would have excluded a sizeable number of passengers on excursions, sports and tour outings. These trips, loosely called charter/tour, involve buses and coaches. In Sydney, buses are used for a large number of charter/tour jobs.

13.3.5. Costs

An issue of great importance is the treatment of costs, which are not incurred by the operator, such as the use of a depot which is fully owned by the operator and for which a market rent is not charged. There is an opportunity cost, based on the market value. The operators have been asked to estimate this opportunity cost.

There are significant differences in the award conditions between States. Most notably, in Victoria a casual is employed a minimum of 3 h/day and carries an average 26% on-cost (relative to the base wage rate), which goes as high as 30%. In NSW, a casual carries a 15% loading plus a 1/12th proportionate holiday pay based on the ordinary hours wage for the pay period. Casual employees in Victoria are close to full-time staff in terms of costs incurred per hour by the operator, making them a less attractive proposition than in NSW.

13.3.6. Specifying the Outputs and Inputs

For each input and output, a quantity must be specified and a weight calculated.

13.3.6.1. Output Quantities and Weights

There are ideally two demand-side (or final) measures of output – passengers or passenger kilometres, and two supply-side (or intermediate) measures of output – vehicle seat kilometres or vehicle seat hours. Passenger kilometres are derived from the product of passengers and average passenger trip length.

We did not ask directly for the average-trip length for charter-tours because of the inherent difficulty in calculating an average across a diversified set of O–D vehicle trips. Accurate calculation would entail the monitoring of a large number of actual charter-tour trips. Through discussions with a number of operators we constructed an estimate of this item from other data items. The average kilometres per coach per annum divided by the number of coach operating days gives an estimate of the average kilometres per day per coach. Assuming that a coach is only used once per day for charter/tours and that all passengers stay with the coach tour over its entirety, then average charter trip length, and hence passenger kilometres for charter/tours can be readily estimated. We checked our calculations against operators who did supply an average trip length for coach, and found a very close relationship. However, this confidence did not generalise to all operators. As a consequence we decided not to use passenger kilometres in the analysis. In future studies, operators will be asked to sample a number of their charter-tour services in order to obtain an accurate measure of average charter passenger trip length.

It is noteworthy that in Queens land only, operators are obliged to keep records for charters and tours including the date, the origin and destination of the trip, the number of passengers and the type of activity. This information is not only useful for calculating average trip length and patronage, it is of intrinsic value to the operator in the determination of the appropriate vehicle size required to accommodate the charter/tour market. Many operators in NSW and Victoria saw little reason for maintaining records on patronage and trip length of charters and tours.

We recognise that passenger kilometres is the preferred measure of final output, but that the element of increased error in the application of average trip length needs to be cushioned by the parallel application using passenger trips. The two measures are identical only when the average trip length is the same across all operators. Passenger trips can be disaggregated into three categories: charter/tour, children going to and from school and the passengers on local scheduled services (excluding children going to/from school). In Victoria, where the private operators are on cost-only contracts with the Victorian government, they have no control or responsibility over revenue and hence passenger trips, except for charter/tours that are outside the terms of the contracts. The private operators in Victoria were however able to supply a disaggregation of contract service passengers by school and non-school trips. A number of *public* bus operators have great difficulty in decomposing their patronage. Very little if any charter/tour work is undertaken in the public sector, so the remaining two categories have to be treated as a fully aggregated passenger trip profile.

The approach we have adopted for incorporating the demand-side measure of output has to allow for the absence of charter/tour services for a number of operators. The complexities of a TFP measure with logarithmic transformations throughout makes zero patronage on charter/tour problematic. To circumvent this problem we can combine the charter/tour and non-schoolchildren passengers into one output measure, giving a two-way distinction of schoolchildren passengers and non-schoolchildren passengers (i.e., all other passengers). The inclusion of charter-tour patronage in mixed-output can be allowed for in the decomposition of GTFP (see below). When comparing all public and private operators, however, the interest herein, we have to use a *single* output passenger measure, until such time as reliable passenger decomposition is available from all operators.

The intermediate measures of output, vehicle seat kilometres and vehicle seat hours, are reported separately for buses and coaches. We would have preferred a breakdown of kilometres and hours into the three passenger categories, but operators had indicated in pilot work that this was impossible to provide. As a consequence we only made a distinction between types of vehicle.

Annual vehicle hours and kilometres include dead running time and distance. This is the vehicle utilisation which is non-revenue earning. Vehicle hours is the preferred measure of intermediate output (rather than vehicle kilometres) because it allows for the quality of the operating environment, especially traffic congestion and delays in boarding and alighting of passengers. Some operators, however, especially, in the public sector, have difficulty in calculating their vehicle hours, which necessitates a consideration of vehicle kilometres.

If output could be identified in the three categories above, then revenue weights would need to be calculated for each category of output. There is a maximum set of six classes of revenue, categorised under the three preferred output dimensions as 'schoolchildren', 'other' and 'charter/tour' passengers:

1. *School children*
   - (1a) student and technical college reimbursement; and
   - (1b) permanent school contracts.
2. *Other*
   - (2a) adult and child fares for timetabled services;
   - (2b) concessional (all types) and reimbursement; and
   - (2c) contracted route services.

13.3.6.2. Charter/Tour (i.e., Excursions, Sport and Tours)

Except for private operators in Victoria, revenue classes (1a) and (1b) define revenue from the carriage of schoolchildren travelling to/from school, revenue classes (2a), (2b) and (2c) define all other revenue except revenue from charters and tours which is Class 3. In Victoria, private operators have only two sources of revenue – contracted route services and charter/tours. All revenue classes apply in principle to public operators, although two of them are unable to identify class-specific revenue. Some operators do not have any coaches (all the public operators and 10 of the private operators). Furthermore, because it is not possible to allocate revenue to coach and bus use where an operator provides both types of vehicles, we have opted for a *single-output* measure for intermediate output, to be used in the calculation of the supply-side measure of GTFP.

13.3.6.3. Input Quantities and Weights

Each operator is assumed to combine five input categories in the production of intermediate or final output. The inputs are labour, energy, non-labour maintenance, capital and other resources. The input quantities are defined as:

(i) *Labour*: total annual paid hours.
(ii) *Energy*: annual litres of fuel consumed.
(iii) *Non-labour maintenance*: total annual vehicle kilometres as a proxy for non-labour maintenance (a reasonable assumption for a single cross section where a price index cannot be used, because it is constant, to convert maintenance expenditure into a quantity index).
(iv) *Vehicle capital*: annual vehicle seat capacity.
(v) *Other resources*: annual expenditure.

The input weights are the expenditure shares. Except for capital the expenditures are derived directly from the spreadsheet data base. The repayments on buses and coaches, which include depreciation and interest are a strictly financial measure of expenses incurred and are not necessarily a measure of the opportunity cost of capital. The annualised cost of capital is calculated, given the average age of the vehicle fleet, and assumptions of the economic life (15 years), the residual value of buses and coaches (15%) and the real rate of interest (8%). The real purchase prices of vehicles when new was obtained from the Price Waterhouse Urwick (1992) model for school buses and advice from industry sources for other vehicles.

The appropriate cost of an asset to be charged against operations during any given period is the opportunity cost of using it during that period. When evaluating the opportunity cost of a bus, the relevant cost is the entire capital cost, to be regarded as an outlay in the period the bus is acquired minus its residual value on sale, and which is regarded as a cash receipt at the time the bus is disposed. Depreciation should not be charged against revenue produced by service provision for this is implicit in the procedure of comparing the discounted benefit and cost streams.

The relevant variables for operations planning are cash flows and opportunity costs rather than costs determined on the basis of arbitrary accounting allocations. An appropriate means of determining capital costs is to use capital recovery factors to determine the annual outlay which would be equivalent, in terms of net-present value, to future cash outlays resulting from an investment decision. The average capital cost per annum (AKC) for a bus is defined as (13.2).

$$AKC = A + (P - S^{*}(1 + r)^{-n})^{*} CRF \qquad (13.2)$$

where CRF is the cost recovery factor $= r/(1-(1+r)^{-n})$; P the bus real purchase price; S the bus real scrap or residual value after n years (15%); R the real rate of interest (8%); A the average annual outlays of bus insurance, registration, licence fees and permits; and N is the average vehicle life (15 years).

To obtain an estimate of the residual value, we draw on earlier work of Hensher (1992b) where we sampled a number of market prices obtained from vehicles disposed in 1988 in the private bus sector. The prices have been averaged to ensure uniform change in relative prices between years. The prices are then converted to constant dollars by calculating the compound rate of increase of a new bus over a 15-year period (approximately 13%) and applying it to the nominal bus prices. The decline in value per annum is then calculated, and the value projected to a constant 15-year life. The ratio of the value projected in constant dollars to a constant 15-year life over the historical cost can be expressed as the average percentage residual or scrap value of a 15-year-old bus. The suggested working percentage is 15%. This percentage is also used by Price Waterhouse Urwick (1992) for school buses.

The final measure of annualised capital cost *replaces* the reported expenditures in the TFP indices, and is used to obtain the expenditure shares for weighting capital input in the derivation of the overall input index. The quantity measure is total vehicle seat capacity, to allow for different sized vehicles, especially since the introduction of mini and midi buses. We now have all the data required to calculate the GTFP index and the partial productivity indices, one for each of the five inputs given in Eq. (13.1).

13.4. DESCRIPTIVE PROFILE OF THE URBAN BUS SECTOR 1991/1992

As a prelude to the calculation of GTFP indices, it is useful to present a number of partial ratio indices, which represent elements of overall performance. In discussion of results and tables, the private operators are identified by a code to ensure confidentiality. The most interesting and useful ratios are summarised in Table 13.1. A close examination of Table 13.1 suggests a number of similarities and differences within and between the three cities for the private operator sample, and between the eight public operators. Overall, on the eight partial ratios, there does not appear to be a *totally* unambiguous case for arguing that private bus operators in one city are *consistently better* performers than are operators in another city. Some ratios (for example, non-labour maintenance and repair costs ($MC/vkm)) tend to be lower for Sydney operators, in comparison to both Brisbane and Melbourne operators. The Sydney operators on average have a lower revenue per passenger ($rev/pass), which may suggest that the operator subsidy in Brisbane is rather generous by national standards, giving a total revenue of $2.42 per passenger compared to $1.44 per passenger in Sydney where there is no special operator subsidy linked to fares. The Melbourne average is distorted upwards by the presence of an operator carrying disabled children over long distances and receiving a relatively high-contract fare. The remaining Melbourne operators have comparable revenue per passenger to Sydney. Low passengers and high revenue is consistent with the output index in Table 13.1 (see later) which gives output indices below average in most cases.

The public operator revenue indicators need special comment. The ex post deficit, which is referred to in some States as a subsidy and in other States as a Community Service Obligation (CSO) has been excluded from the measure of revenue. In contrast any ex ante agreed subsidy, which goes to the private operators in Queensland is included in the revenue source. No such subsidy is available to private operators in Sydney and Melbourne. While it is recognised that there may be a case for establishing a consistent set of rules for handling all forms of 'subsidy', we have opted for the inclusion of all forms of up-front (ex ante) subsidy payments in the definition of revenue and excluded what are essentially ex post balancing items to cover shortfalls in revenue. This ex post allocation has been excluded for all public operators. Concessional reimbursements are not viewed as a subsidy but as a payment to operators from government, which represents the shortfall in revenue from concession fares. Metro in Tasmania does not receive any such concessional reimbursement, unlike all other operators. Since we use a single output in TFP, the issue of error in revenue shares does not arise. Further consideration of this issue is required in ongoing studies.

A most noticeable difference between public and private operators is on total cost per vehicle kilometre. Except for the one Melbourne private

Table 13.1. Selected Partial Ratio Measures of Performance, 1991–1992.

	$rev/cost	$rev/pass	$TC/vkm	$LC/vkm	$MC/vkm	$Kap/vkm	$TC/pass	$LC/PdHr
S1	0.998	1.331	2.170	1.253	0.098	0.484	1.334	22.89
S2	0.957	1.231	2.209	1.063	0.169	0.376	1.269	18.95
S3	1.059	2.525	2.591	0.828	0.193	0.410	2.359	10.87
S4	0.784	1.234	2.482	1.276	0.212	0.213	1.551	17.30
S5	1.163	1.301	1.788	0.961	0.114	0.373	1.118	19.89
S6	1.153	1.220	2.104	1.336	0.096	0.313	1.058	22.53
S7	1.309	1.054	1.941	0.987	0.124	0.439	0.801	18.45
S8	1.242	0.985	2.007	1.018	0.155	0.435	0.787	16.19
S9	1.158	1.382	1.841	0.963	0.146	0.392	1.180	17.95
S10	1.043	1.878	1.879	0.732	0.167	0.515	1.775	11.75
S11	1.185	1.975	1.630	0.788	0.146	0.316	1.656	15.81
S12	0.865	1.162	2.813	1.433	0.175	0.615	1.333	20.90
Average in Sydney	1.076	1.440	2.121	1.053	0.150	0.407	1.352	17.79
B1	1.071	2.039	2.448	0.925	0.254	0.766	1.904	17.60
B2	0.935	2.575	2.033	0.754	0.218	0.599	2.697	14.62
B3	1.078	2.891	2.040	0.695	0.261	0.619	2.614	15.75
B4	0.998	2.846	2.339	0.980	0.231	0.385	2.703	14.90
B5	0.729	1.943	2.443	0.948	0.184	0.590	2.562	16.50
B6	1.254	2.220	1.726	0.840	0.188	0.309	1.369	14.79
Average in Brisbane	1.011	2.419	2.172	0.857	0.223	0.544	2.308	15.69
M1	1.079	1.547	2.635	1.598	0.312	0.284	1.433	19.25
M2	1.013	2.161	2.235	1.173	0.185	0.524	2.132	15.72
M3	1.106	1.368	2.413	1.539	0.216	0.197	1.237	15.77
M4	1.014	1.744	2.171	1.324	0.161	0.262	1.691	17.25
M5	0.893	4.371	2.732	1.116	0.194	0.517	4.880	16.75
M6	0.964	1.474	1.675	0.917	0.161	0.315	1.529	15.11

Average in Melbourne	1.012	2.111	2.310	1.278	0.205	0.350	2.150	16.64
Average in private	1.044	1.852	2.181	1.060	0.182	0.427	1.791	16.98
STA (NSW)	0.880	1.279	4.069	2.571	0.186	0.297	1.453	19.74
Action	0.310	0.962	3.985	2.381	0.312	0.557	3.100	19.62
PTC	0.287	0.680	3.278	2.432	0.123	0.414	2.372	19.65
BCC	0.483	0.987	2.887	1.932	0.112	0.381	2.045	18.42
STA (SA)	0.421	1.008	3.663	2.212	0.204	0.770	2.392	17.10
Transperth	0.375	1.006	2.709	1.648	0.105	0.532	2.684	14.78
Metro	0.340	0.930	3.215	2.085	0.102	0.566	2.736	17.00
Darwin BS	0.401	0.966	2.634	0.851	0.182	0.150	2.409	13.83
Average in public	0.437	0.977	3.305	2.014	0.166	0.458	2.399	17.52
Average in all	0.892	1.634	2.462	1.299	0.177	0.435	1.943	17.11

Note: $rev/cost: ratio of revenue to costs
$pass/vkm: passengers per vehicle km
$rev/vkm: revenue per vehicle km
$rev/pass: revenue per passenger
$TC/vkm: total costs per vehicle km
$TC/vh: total cost per vehicle hour
$LC/vkm: labour cost per vehicle km
$MC/vkm: non-labour maintenance costs per vehicle km
$Kap/vkm: capital costs per vehicle km (based on operator-reported vehicle repayments)
$Oth/vkm: other costs (overheads) per vehicle km
$TC/pass: total costs per passenger
$LC/pdh: labour costs per paid hour
vkm/veh: vehicle kms per vehicle (in 000)
%LC in ohds: per cent of labour costs (including oncosts) that are for office and depot staff
% emp casual: per cent of total employees that are casual
fleet age: average age of fleet (all vehicles) (to nearest year).

operator (M5) who has a specialised service for the disabled, the public operators are significantly more costly per vehicle kilometre, averaging 50% higher unit cost per vkm. One other Melbourne operator (M1) comes close to the best performing public operator (P8) on unit cost per vkm. The Melbourne operators on average have higher total costs per vehicle kilometre than the Sydney and Brisbane operators, largely attributed to labour costs per vkm, although the spread suggests that there are no significant city differences. However, labour costs per paid hour are on average higher in Sydney, but are spread over a larger amount of supplied vehicle kilometres.

The differences are possibly as significant *within* each capital city as they are *between* capital cities. The most notable differences occur when private and public operators are compared, although once again there are substantial variations within the set of public operators that create overlaps between the two groupings on nearly all partial measures. The message from the comparisons of partial ratios, especially within the public operators, is that there are a large number of different rankings of operators across the partial measures, which leaves open any expectations as to which operators will be the best performers on gross TFP. There are, however, some reasonable grounds for conjecturing that STA(NSW), Brisbane Transport, Transperth and STA(SA) will perform relatively well within the public operators, depending on the definition of output.

The evaluation of partial measures highlights some interesting relationships; however, the rankings of operators on each single ratio vary substantially, making it difficult to decide which partial indicators are the most useful in a study of performance measurement and monitoring. It is for this reason, among other reasons that a global index and decomposition of its sources of variation is attractive.

13.5. GROSS TOTAL FACTOR PRODUCTIVITY

13.5.1. Gross TFP

The GTFP indices together with the aggregate output quantity measures and the aggregate input index are summarised in Table 13.2. The GTFP indices have been rescaled to a base of 100 for the most productive operator. A summary of the individual input indices (I-lab, I-energy, I-nonlm, I-kap and I-other) and cost shares (C-lab, C-energy, C-nonlm, C-kap and C-other) is given in Table 13.3. A positive output index suggests that the operator is *above* average in output, a positive input index suggests that an operator is

Table 13.2. Summary of GTFP Indices, Output Indices and the Aggregate Input Index.

Operator	GTFPpass	Rank Order	GTFPvkm	Rank Order	Q-Pass index	Q-vkm index	I-index
NSW							
S1	67.82	6	89.74	6	−1.22	−1.20	−1.72
S2	61.25	9	75.75	15	−0.90	−0.94	−1.30
S3	25.77	31	50.52	30	−2.23	−1.81	−1.76
S4	42.79	15	57.57	23	−2.25	−2.21	−2.27
S5	74.30	4	100.00	1	−1.77	−1.72	−2.34
S6	80.68	3	87.36	8	−0.70	−0.88	−1.37
S7	100.00	1	88.85	7	−0.71	−1.08	−1.59
S8	94.98	2	80.21	10	−1.04	−1.46	−1.86
S9	65.24	7	90.07	4	−1.78	−1.71	−2.22
S10	38.30	18	77.89	13	−1.37	−0.91	−1.29
S11	42.10	16	92.10	2	−2.62	−2.09	−2.62
S12	63.91	8	65.18	19	−1.33	−1.56	−1.77
Average in Sydney	63.10	–	79.60	–	−1.493	−1.464	−1.851
QLD							
B1	47.11	13	78.86	12	−2.93	−2.67	−3.04
B2	27.69	27	79.08	11	−2.62	−1.82	−2.22
B3	33.33	23	91.94	3	−1.67	−0.91	−1.46
B4	25.78	30	64.13	20	−2.34	−1.68	−1.86
B5	29.88	26	67.47	17	−1.97	−1.41	−1.65
B6	48.83	12	83.35	9	−1.25	−0.97	−1.41

Table 13.2. (*Continued*)

Operator	GTFPpass	Rank Order	GTFPvkm	Rank Order	Q-Pass index	Q-vkm index	I-index
Average in Brisbane	35.44	–	77.47	–	−2.129	−1.577	−1.948
VIC							
M1	56.75	10	66.44	18	−2.43	−2.52	−2.72
M2	37.31	19	76.59	14	−2.31	−1.84	−2.19
M3	51.66	11	57.01	24	−2.56	−2.72	−2.75
M4	41.74	17	69.98	16	−0.54	−0.28	−0.56
M5	15.25	32	58.66	22	−3.14	−2.05	−2.14
M6	45.76	14	89.94	5	−2.51	−2.09	−2.58
Average in Melbourne	41.41	–	69.77	–	−2.248	−1.916	−2.177
Average in private	50.76	–	76.61	–	−1.841	−1.605	−1.957
Public							
STA (NSW)	71.44	5 [1]	54.90	27 [4]	2.53	2.02	1.97
Action	30.28	25 [6]	50.71	29 [6]	0.49	0.75	0.79
PTC	34.73	22 [4]	54.12	28 [5]	0.48	0.67	0.67
BCC	37.04	20 [2]	56.48	25 [2]	1.06	1.23	1.16
STA (SA)	35.65	21 [3]	50.11	31 [7]	1.39	1.47	1.52
Transperth	26.29	29 [8]	56.07	26 [3]	1.18	1.68	1.62
Metro	26.92	28 [7]	49.32	32 [8]	−0.22	0.13	0.21
DBS	30.62	24 [5]	60.29	21 [1]	−1.69	−1.27	−1.41
Average in public	36.62	–	54.00	–	0.653	0.836	0.821
Average in all	47.23	–	70.96	–	−1.217	−0.995	−1.262

Note: [ ] is ranking within set of public operators.

Table 13.3. Summary of Input Indices and Associated Cost Shares, 1991–1992.

Operator	I-lab	C-lab	I-energy	C-energy	I-nonlm	C-nonlm	I-kap	C-kap	I-other	C-other
NSW										
S1	−1.18	0.66	−0.15	0.11	−0.08	0.05	−0.07	0.11	−0.24	0.07
S2	−1.00	0.53	−0.10	0.11	−0.07	0.08	−0.05	0.09	−0.08	0.18
S3	−1.24	0.34	−0.18	0.10	−0.14	0.08	−0.13	0.10	−0.08	0.38
S4	−1.54	0.52	−0.23	0.09	−0.17	0.09	−0.17	0.08	−0.18	0.23
S5	−1.54	0.59	−0.21	0.14	−0.13	0.07	−0.13	0.14	−0.34	0.07
S6	−0.94	0.68	−0.09	0.13	−0.06	0.05	−0.06	0.09	−0.23	0.05
S7	−1.12	0.60	−0.11	0.14	−0.08	0.07	−0.10	0.09	−0.20	0.10
S8	−1.23	0.57	−0.15	0.14	−0.11	0.09	−0.13	0.12	−0.25	0.09
S9	−1.48	0.59	−0.20	0.12	−0.13	0.09	−0.13	0.11	−0.30	0.08
S10	−0.92	0.47	−0.10	0.15	−0.06	0.11	−0.08	0.12	−0.13	0.15
S11	−1.69	0.52	−0.24	0.15	−0.17	0.10	−0.18	0.14	−0.36	0.10
S12	−1.24	0.57	−0.16	0.09	−0.11	0.07	−0.09	0.12	−0.16	0.14
Average in Sydney	−1.259	0.553	−0.160	0.123	−0.109	0.079	−0.109	0.108	−0.213	0.137
QLD										
B1	−1.91	0.46	−0.30	0.13	−0.25	0.13	−0.21	0.16	−0.40	0.12
B2	−1.48	0.44	−0.20	0.13	−0.16	0.13	−0.12	0.16	−0.27	0.14
B3	−1.09	0.43	−0.08	0.14	−0.06	0.16	−0.10	0.13	−0.13	0.15
B4	−1.29	0.45	−0.17	0.11	−0.13	0.11	−0.14	0.11	−0.14	0.23
B5	−1.22	0.46	−0.13	0.09	−0.11	0.09	−0.10	0.11	−0.09	0.25
B6	−1.01	0.53	−0.09	0.14	−0.07	0.12	−0.08	0.11	−0.18	0.11
Average in Brisbane	−1.333	0.460	−0.162	0.124	−0.129	0.121	−0.123	0.130	−0.201	0.165
VIC										
M1	−1.72	0.62	−0.28	0.10	−0.23	0.12	−0.19	0.08	−0.33	0.08
M2	−1.37	0.61	−0.20	0.12	−0.15	0.10	−0.16	0.11	−0.32	0.07
M3	−1.75	0.63	−0.29	0.08	−0.22	0.09	−0.21	0.09	−0.33	0.11
M4	−0.42	0.64	−0.04	0.10	−0.01	0.08	−0.02	0.08	−0.07	0.11

Table 13.3. *(Continued)*

Operator	I-lab	C-lab	I-energy	C-energy	I-nonlm	C-nonlm	I-kap	C-kap	I-other	C-other
M5	−1.47	0.45	−0.22	0.08	−0.16	0.08	−0.17	0.11	−0.14	0.28
M6	−1.63	0.61	−0.25	0.11	−0.17	0.11	−0.19	0.10	−0.36	0.08
Average in Melbourne	−1.392	0.595	−0.214	0.098	−0.156	0.095	−0.157	0.093	−0.258	0.119
Average in private	−1.311	0.540	−0.174	0.117	−0.126	0.093	−0.125	0.110	−0.221	0.140
Public										
STA (NSW)	1.33	0.66	0.17	0.06	0.13	0.05	0.13	0.04	0.23	0.20
Action	0.51	0.67	0.05	0.07	0.08	0.09	0.06	0.04	0.09	0.14
PTC	0.63	0.80	0.07	0.08	0.03	0.04	0.04	0.05	−0.12	0.02
BCC	0.81	0.73	0.13	0.09	0.07	0.04	0.09	0.05	0.07	0.09
STA (SA)	1.11	0.74	0.13	0.08	0.12	0.07	0.09	0.04	0.09	0.08
Transperth	1.12	0.71	0.18	0.10	0.10	0.05	0.12	0.06	0.10	0.08
Metro	0.20	0.74	0.01	0.08	0.00	0.04	0.03	0.06	−0.03	0.08
DBS	−1.08	0.33	−0.14	0.07	−0.09	0.07	−0.08	0.05	−0.01	0.49
Average in public	0.578	0.671	0.077	0.079	−0.055	0.055	0.059	0.049	0.053	0.146
Average in all	−0.839	0.573	−0.111	0.108	−0.081	0.084	−0.079	0.095	−0.153	0.141

Note: I-lab: input index for labour
I-energy: input index for energy
I-nonlm: input index for non-labour maintenance
I-kap: input index for capital (economists' definition, not operator reported costs)
I-other: input index for other costs (overheads)
C-lab: labour costs' share of total costs
C-energy: energy costs' share of total costs
C-nonlm: non-labour maintenance costs' share of total costs
C-kap: capital costs' share of total costs
C-other: other costs' share of total costs.

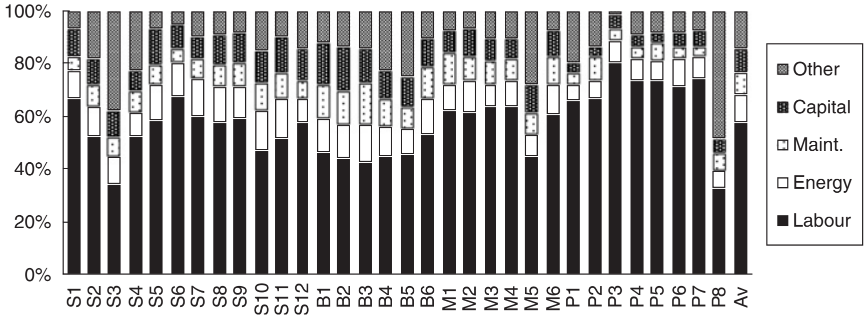


Fig. 13.2. Cost Shares of Inputs (using Calculated Opportunity Cost of Capital).

below average in the use of inputs. The cost shares of the five inputs are shown in Fig. 13.2.

All private operators were able to report both revenue and patronage data in terms of school passengers and other scheduled route passengers. A few private operators reported no charter/tour activity. The public operators had great difficulty in reporting patronage by these categories, even though most public operators could distinguish revenue from these sources. However, many public operators do not have charter/tour activities, which is problematic when creating an output index, and hence a GTFP index with zero entries in a part of a complicated formula riddled with logarithmic transformations. Treating operators with and without charter-tour services as one way of circumventing this problem would be unacceptable because it prevents a meaningful comparison across all operators, given the *relative* nature of the GTFP index. In comparisons across all 32 operators we have been forced to treat output as a single dimension. A separate investigation of private operators would permit the development of an output index with two outputs, but this is not as useful as a comparative assessment of *all* public and private operators.

We have sorted the 32 operators into four quartiles (Tables 13.4 and 13.5) to give an interesting perspective on the incidence of operators from each of the four groupings in each quartile. Overall, the private operators in Sydney are the most productive on both measures of GTFP.

In comparing the results for GTFPpass and GTFPvkm, the public operators fare better on passengers than vehicle kilometres because of the relative advantage they have in serving the inner-to-middle suburbs of major urban areas in contrast to the private operators. Some public operators, however, also serve the outer suburbs (i.e., Transperth and ACTION).

Table 13.4. Quartile Incidence of Group Membership: GTFPpass and GTFPvkm (the latter in parentheses).

Quartile (Q)	Private Sydney	Private Brisbane	Private Melbourne	Public
1st Q (1–8 rank)	7 (6)	0 (1)	0 (1)	1 (0)
2nd Q (9–16 rank)	3 (4)	2 (3)	3 (2)	0 (0)
3rd Q (17–24 rank)	1 (2)	1 (2)	2 (3)	4 (1)
4th Q (25–32 rank)	1 (1)	3 (0)	1 (0)	3 (7)
Total	12 (12)	6 (6)	6 (6)	8 (8)

Note: The term 'scaled adjusted TFP' used in the following table heading has not yet been explained in the text.

Table 13.5. Quartile Incidence of Group Membership: Scale-adjusted TFPpass and Scale-adjusted TFPvkm (the latter in parentheses).

Quartile (Q)	Private Sydney	Private Brisbane	Private Melbourne	Public
1st Q (1–8 rank)	7 (5)	0 (2)	0 (1)	1 (0)
2nd Q (9–16 rank)	3 (4)	2 (2)	3 (2)	0 (0)
3rd Q (17–24 rank)	1 (2)	2 (2)	2 (3)	3 (1)
4th Q (25–32 rank)	1 (1)	2 (0)	1 (0)	4 (7)
Total	12 (12)	6 (6)	6 (6)	8 (8)

However, even given this 'patronage advantage', for other reasons public operators do not in general (or are not able to) employ resources in a sufficiently efficient or effective manner to gain a productive advantage over private operators. Interestingly all operators in the top quartile on GTFP-pass are Sydney based, including the public operator, and six of the eight operators in the top quartile based on GTFPvkm are also Sydney operators. One Sydney operator (S3), however, might be described as a *Sydney outlier*, performing extremely poorly (ranks 31 and 30) on both measures of GTFP.

The seven largest public operators (Darwin Bus Service being excluded) are in the bottom quartile on GTFPvkm (see Table 13.5). They perform relatively poorly in the way they use their inputs to produce vehicle kilometres of service although some have an attractive market of patronage by advantage of location. Their loadings come to the rescue in part, elevating three of the seven public operators on GTFPpass to the third quartile (PTC, BCC and STA(SA)) and one to the top quartile (STA(NSW)).

The Melbourne and Brisbane private operators reside, in the main, within the middle two quartiles, with Melbourne operators having the edge over Brisbane operators on GTFPpass and vice versa for GTFPvkm. Overall, the private bus operators in Sydney are the most productive on GTFPpass, followed by the Melbourne private operators, the Brisbane private operators and then the public operators (Table 13.2). On TFPvkm, the private operators across the states are on average quite similar, but more efficient than the public operators. On average the private operators are 40% more productive on both gross indices of GTFP than the public operators before adjusting for scale and scope, and after adjusting for scale and scope they are 67% more productive on TFPpass and 120% more productive on TFPvkm. While this difference is broadly valid for comparisons between all public operators and private operators in *each* State for GTFPvkm, the difference on GTFPpass, however, is largely due to the relative cost effectiveness of the private Sydney operators. The difference on average between the public operators and the Melbourne or Brisbane private operators is negligible.

It is noteworthy that the regulatory arrangements in Queensland and Victoria are currently under major review. The outcome of the expected reforms is likely to give operators greater opportunities to be more cost efficient and cost effective. Continued monitoring of the industry will be important in confirming this.

When one compares operators on GTFPvkm, where the output relates to a service level, which the operator can control to a greater extent than the patronage levels (although there are degrees of differences in the ability to vary route services), a different picture emerges. On average, the private operators are 42% more cost efficient than the public operators. However, the variation in mean GTFPvkm between the three private operator groups is considerably less than is the case on GTFPpass. A maximum 12% difference (with Sydney the best, followed by Brisbane and then Melbourne) when related to the within-group variation is not a statistically significant variation to infer that one State's private operators have any inherent advantage in the way they use their inputs to produce their vehicle kilometres at minimum cost. The separate rankings of operators by the aggregate input index and the aggregate output index (Table 13.3) provide strong evidence that the correlation between State and rank order is not significant.

Table 13.6. Comparison of Private Operators with their Own State Public Operator.

Location	On GTFPpassenger Measure	On GTFPvkm Measure
Sydney privates are …	12% less effective than STA (NSW)	45% more efficient than STA (NSW)
Brisbane privates are …	4% less effective than BCC	37% more efficient than BCC
Melbourne privates are …	19% more effective than PTC (Vic)	29% more efficient than PTC (Vic)

The Sydney finding on GTFPpass confirms the strategic advantage that STA(NSW) has in its service market area, and that although the private operators overall have cancelled out some of the passenger market advantage by being more efficient in the use of inputs to produce vehicle kilometres designed to attract patronage (combined with fares, etc.), the locational disadvantage, primarily in terms of density of traffic and the competition with the automobile, is not sufficiently strong to compensate. When one compares the private operators in each city with their local public operator, we find the relative performances as summarised in Table 13.6.

Even if we eliminated the Sydney outlier, the 12% less effective mean for Sydney becomes 9% less effective. Only four of the 12 Sydney operators have a GTFPpass higher than STA(NSW). In contrast, all but the *Sydney outlier* have a GTFPvkm higher than STA(NSW). In Melbourne, four of the six private operators have a GTFPpass higher than PTC(Vic), and in Brisbane only two of the six private operators have a GTFPpass higher than Brisbane Transport. In all instances, GTFPvkm is higher for all private operators compared to the local public operator. There is a very important message here – *the advantage conveyed to a public operator through location is not translated into actions, which ensure that inputs are used to produce intermediate outputs at the lowest cost*. Thus, if private operators were to supply the equivalent service currently offered by the public operators in the public operators' service area, we should expect a significant improvement in GTFPpass, *given* GTFPvkm.

Within the set of public operators, the expectations from the analysis of the partial ratios in Table 13.1 have in large measure been confirmed. Brisbane Transport ranks second on both GTFPpass and GTFPvkm, the most consistent result, which contrasts with STA(NSW) the most cost-effective operator (ranked 4th on cost efficiency–GTFPvkm), and Darwin Bus service the most cost efficient (ranked 5th on cost effectiveness–GTFPpass). Transperth's passenger levels are a problem, giving it the worst cost effectiveness of the public operators. Metro in Tasmania is the worst on cost efficiency. In recognising that some of the absolute GTFP indices are close in value, we might suggest that some of the differences 'are too close to call'.

Taking this into account, the public operators can be ranked as follows:

For GTFPpass	For GTFPvkm
1 = STA (NSW)	1 = Darwin Bus Service
2 = Brisbane CC	2 = Brisbane CC, Transperth
3 = STA (SA)	3 = STA (NSW), PTC
4 = PTC	4 = STA (SA), ACTION
5 = ACTION, Darwin Bus Service	5 = Metro
6 = Transperth, Metro	

Given the continued interest by operators in the partial ratios in Table 13.1, a simple regression of GTFP against each of the partial ratios is an informative exercise. Overall, we found a very low level of explanatory power on most ratios. For GTFPpass, the only partial ratio with a strong-partial correlation was passengers per vkm (partial correlation of 0.86), which means that 73% of the variation in GTFPpass across the sample can be explained by the partial ratio passengers per vehicle kilometre. The partial ratios with a reasonably strong partial correlation with GTFPvkm are cost per vehicle kilometre (−0.82), kilometres per vehicle (0.67) and labour costs per vehicle kilometre (−0.66). Approximately 70% of the variation in GTFPvkm can be explained by these three partial ratios. The message is clear:

> differences in cost efficiency are linked to fleet utilisation, labour utilisation and the overall cost of servicing a kilometre of vehicle provision;
>
> differences in cost effectiveness are linked to the ability to attract patronage to each kilometre of vehicle provision.

Also of interest is a recognition that there is a somewhat weak relationship between GTFPpass and GTFPvkm. A simple linear regression shows that 24.7% of the variation in cost effectiveness can be explained by variation in cost efficiency across the sample. Hence, there are many other issues to consider. This also highlights the importance of having both measures – they are not substitutes. As a minimum requirement, an operator will find monitoring of passengers per vehicle kilometre, cost per vehicle kilometre and kilometres per vehicle useful indicative measures of overall cost effectiveness and cost efficiency.

The discussion thus far has centred on the overall productivity of each operator, with a preliminary exploration of the broad sources of variation in GTFPpass and GTFPvkm. Some possible reasons for the differences in performance have been conjectured. To gain a better appreciation of the differences we need to undertake a formal statistical analysis capable of identifying the sources of variation in both indices of GTFP. We now turn to this task.

13.5.2. Decomposing GTFP to Identify Sources of Productivity Differences

There may be several factors which influence performance, only some of those are subjected to managerial control. In making performance comparisons among enterprises, it is desirable to separate out exogenous influences on performance. For example, bus companies operating in difficult terrain and low-density population may show higher input use per output than companies operating in more favourable circumstances. Another example: if economies of scale and scope are important, then enterprises with growing markets will tend to improve performance relative to firms with stagnant markets. The advantages of size and scope are inherent in increasing returns technologies. Generally, performance measurement tries to separate exogenous influences on performance from those attributable to managerial or policy variables (e.g., subsidy policy, ownership status, management structure). Econometric or parametric methods of performance measurement incorporate these exogenous influences directly as part of estimating performance measures. Non-parametric methods such as index number approaches to TFP, as used herein, adjust for exogenous influences on productivity by the decomposition of GTFP after the *gross* measure of TFP is calculated.

An important task is to identify the extent to which the institutional and regulatory context has a positive or negative influence on relative productivity. In designing the data specifications, we had to ensure that there were sufficient data items which were quantitative representations of the different institutional and regulatory contexts across all of the private and public operators. Furthermore, where a broad indicator such as ownership (i.e., public vs. private) is used to represent a particular dimension of institutional influence such as 'independence or lack of direct interference from the political process', one has to be careful to remove any other effects which are highly correlated with these aggregate indicators.

It is only by identifying how much of the GTFP differences can be explained by factors both controlled and non-controlled by the bus operator that we can identify the unexplained or residual portion of GTFP (i.e., ResTFP), and thus make valid comparisons. The set of possible sources of GTFP differences can be broadly classified into the following categories.

13.5.2.1. Possible Sources of Differences

(i) *Scale, scope, density and network effects.* The output index embodies the size and diversity of output. However, to approximate for the effect of the structure of the network, a difficult feature to quantify, we use the number of unique routes. The larger the number of route services, the greater the likelihood of a more complex and non-linear network of services. An operator with a single long route of the same kilometres of an operator with five routes has an inherent cost advantage producing a different network effect. The incidence of dead running time and average passenger trip length are considerations here.

(ii) *Institutional and regulatory effects.* The two-way classification of ownership status by State represents a rich set of institutional and regulatory contrasts. We have already identified some differences between the private and public operators, which in broad terms are the cost-only contract management approach in Victoria (except for charters and tours); the competitive regulation environment in NSW under the 1990 NSW Passenger Transport Act that imposes minimum levels of service, maximum scheduled fares, maximum fleet average age and a threat of entry through competitive tendering for an incumbent who does not comply under the Act; and the Queens land operating subsidy plus a subsidy on interest repayments for vehicle purchase.

(iii) *Location and demographic specific effects.* Some operators serve areas of high-population density, while others have a very sparse population from which to derive patronage. Together with the traffic congestion (proxied by average speed), and the age composition of passengers, we can allow for the role of locational constraints on relative TFP. Given the difficulty in defining the service area and its population, especially for the outer urban area services, we have classified operating environments in terms of a number of categories representing high- to low-population catchments. Within NSW, each operator has given us their minimum service-level grading, which adds a further dimension to the location effect.

(iv) *Other contextual effects.* There are a number of other possible sources of explanation for differences in GTFP, which are worthy of investigation.

These include:

(a) The presence of coaches in the fleet, represented by a dummy variable (1,0) for presence and absence, or a proportion of all vehicles, or proportion of all vehicle kilometres or vehicle hours of operation. A minibus dummy variable should also be evaluated to assess the role of smaller vehicles with greater fuel efficiency, operating costs and higher frequency of use. Allowance for articulated vehicles is also necessary.
(b) The mix of casual and full-time employees, which gives the private operators a cost advantage over the public operators. Casual staff are usually not employed in school vacation periods. The public operators are not allowed to employ casual or part-time staff in driving buses or maintaining them. These known-work practices and multi-skilling advantages are a distinguishing feature between private and public operators, as is the presence of proprietors in the workforce.
(c) The incidence of sick days actually taken has historically been a noticeable feature of a comparison of private and public operations. Even with the same entitlements, there has historically been a much higher incidence of lost-working hours in the public sector through 'sickness'.
(d) The mix of inputs, especially the ratio of labour to other inputs, and the ratio of expenditure on maintenance and other items, provides one means of identifying the possibility of overstaffing in the public operations.
(e) The age of the vehicle fleet, and in particular the capital stock (i.e., number of vehicles). The latter is a means of investigating the possibility of excess capacity.
(f) The size of the deficit in the public sector.

13.5.2.2. Empirical Evidence on Sources of Difference in Gross TFP

A three-stage procedure was implemented to identify the sources of statistical variation in the gross measure of total-factor productivity. Stage 1 involved a linear regression of GTFP and the output index to establish the influence of scale. When comparing firms which have sizeable differences in patronage levels and scales of operation (the latter proxied by total annual vehicle kilometres of service), it is important to identify and allow for the possibility that relative productivity is driven by the greater or lesser opportunity for firms of different sizes to adjust their costs in response to adjustments in inputs. The scale effect herein represents both scale and diversity of service (i.e., scope). We have not separated these two effects out; the single output is based on an underlying composition in terms of trips and vehicle kilometres related to scheduled services, charter/tours, etc. Thus, 'scale' is a shorthand notation for 'scale and scope'.

It is common practice to include the scale effect together with other potential sources of influence on the variation in GTFP into a single equation. However a closer examination of many identifiably important influences of an institutional and broader contextual nature on productivity differences suggests a sufficiently high degree of partial correlation with scale (sometimes with spurious correlation in a causal sense) that a two-step procedure was required. From Stage 1, the scale effect was identified and 'netted out' of the GTFP index to give a scale-adjusted TFP (SATFP). Stage 2 involved a regression model of SATFP and a set of potential sources of variation. The resulting empirical model was used in Stage 3 to obtain a residual index of TFP. Table 13.7 contains the decomposition models.

The results in Table 13.7 provide some important insights into the sources of variation in GTFP. The final set of factors explain over 70% of the variation in GTFP across the 32 operators. We have been careful in the selection of explanatory effects, ensuring that we have fully investigated sources of potential influence within each category outlined in the previous section, as well as testing for any possible statistical source of confoundment (i.e., multi-collinearity) between the explanatory variables. Typically in data of the sort collected for this study, there is a possibility of high partial correlation between seemingly different influences on performance. For example, (i) the output index for passengers (OPASS) has a partial correlation with each of the dummy variables for private operator groups (i.e., SYD, MEL and BRS) which is greater than that with GTFP; (ii) the percentage of dead running time and the private Brisbane dummy variable has a partial correlation of 0.58; and (iii) the number of routes and the output index defined by vehicle kilometres has a partial correlation of 0.77, which contrasts with a −0.44 correlation between the number of routes and GTFPvkm.

A comparison of GTFP and scale-adjusted TFP for vehicle kilometres is quite revealing. For public operators, the scale (and scope) effect is quite marked. Given the generally accepted evidence of constant returns to scale in the local bus industry (e.g., Hensher, 1992b), the deterioration in TFPvkm for public operators relative to private operators is most likely attributable to the limited diversity of services (i.e., scope). This is an important issue, which should be further considered in later studies.

Overall, the three strongest effects on variations in scale-adjusted TFPpass are the SYD dummy variable representing the private operators in Sydney (SYD) – a positive effect, the incidence of coach kilometres in the

Table 13.7. Establishment of Sources of Variation in GTFP and Scale-adjusted GTFP.

Explanatory Variables	Parameter Estimates	*t*-Values
(i) Output = Passengers		
Constant	1.2016	2.30
Output	0.044933	0.81
Adjusted R^2	0.15	
Constant	0.25448	1.65
Sydney private operators (1,0)	0.85469	4.46
Melbourne private operators (1,0)	0.72716	3.87
Brisbane private operators (1,0)	0.34410	2.20
Passengers per catchment area population	0.010902	4.19
No. of mini-vehicles in fleet (0 for public)	0.01077	2.39
Ratio of casual to total employees (including proprietors) (0 for public)	0.45364	2.02
Per cent kilometres which are by coach (0 for public)	−1.9862	−4.46
Adjusted R^2	0.72	
(ii) Output = Vehicle kilometres		
Constant	1.2369	2.34
Output	−0.10052	−3.73
Adjusted R^2	0.20	
Constant	0.27606	2.05
Kilometres per vehicle	0.018212	7.50
Per cent of passengers who are school children (0 for public)	0.19898	3.32
Per cent of costs which are non-labour overheads	−0.51380	−1.76
No. of mini-vehicles in fleet (0 for public)	0.011244	5.76
Ratio of casual to total employees (including proprietors) (0 for public)	0.75419	5.14
Per cent kilometres which are by coach (0 for public)	−0.46086	−2.25
Adjusted R^2	0.76	

Note: 32 observations. Ordinary least-squares regression with heteroscedastic correction.

total fleet kilometres (COAKMP) – a negative effect, and the incidence of patronage from the catchment area population (PASSPOP) – a positive effect. The latter variable is a measure of the success in attracting the population to use the bus services. Other contributing effects are the mix of casual and full-time labour (CASP), fleet diversification in the private sector defined by the number of mini vehicles (MINI), private operator specific dummy variables for the Melbourne operators (MEL) and the Brisbane operators (BRS), all with positive effects.

The statistically significant sources of variation in scale-adjusted GTFPvkm are fleet utilisation defined by annual kilometres per vehicle (KMVEH) – a positive effect; the proportion of non-labour overheads (OTH$WK) – a negative effect; the incidence of coach kilometres in the total fleet kilometres (COAKMP) – a negative effect; the mix of casual and full-time labour (CASP) – a positive effect; fleet diversification in the private sector defined by the number of mini vehicles (MINI) – a positive effect; and the proportion of passengers carried by private operators that are schoolchildren (SCHTOTP) – a positive effect. A private vs. public ownership effect was not included in the GTFPvkm model, because of its high correlation with SCHTOTP (0.79), the latter being an important distinguishing characteristic of private operators compared to public operators. A private operator whose primary patronage is schoolchildren (as in the case of S5 with 69% carriage of schoolchildren), tends to have a higher GTFPvkm, ceteris paribus. The institutional and regulatory effects are best represented by the private operator specific dummy variables (SYD, MEL, BRS) and CASP. A number of important implications flow from a careful interpretation of Table 13.7 in conjunction with Tables 13.5 and 13.6.

First, the presence of an efficient private bus industry in Sydney, reinforced by the NSW Minister of Transport's repeated statements about a select number of these private operators being the benchmark for the STA(NSW), has provided a 'competitive' threat which appears to be having a positive influence on the STA(NSW)'s performance. Discussions with senior STA(NSW) staff tend to confirm this position.

Second, the changing status of Transperth is noteworthy. Transperth has for many years been regarded as one of the best public operators. A closer look at the results for 1991/1992 (combined with an unreported time series profile) shows Transperth as the most efficient public operator in terms of GTFPvkm through the 1980s up to 1989/1990. From 1985 to 1986, however, Transperth's GTFPvkm has been declining, which (except for Darwin Bus Service), has gone against the general trend of a levelling out or an increase in GTFPvkm. Transperth maintained its lead however until 1991/1992 when it fell below Brisbane Transport and Darwin Bus Service (DBS). In 1991/1992, DBS scaled down its inputs quite significantly (see I-index in Table 13.3), especially labour and maintenance, while reducing its bus services less proportionately (see Q-vkm in Table 13.3). The challenge facing Transperth appears to be best highlighted by their aggregate input-index value of 1.62, which is relatively high given the size of Transperth's services output.

Transperth has never been the best performer in respect of GTFPpass, which might be expected given its relatively small catchment compared to the Eastern States. This highlights the importance of adjusting for scale where passengers are the measure of output. Clearly Transperth's past reputation arises from its ability to use its inputs to produce vehicle kilometres (and vehicle hours) at the lowest cost (although there are signs of this reputation being eroded), but is handicapped by access to a relatively small market. Partial performance measures which fail to allow for these external factors that are not under the full or partial control of the operator are particularly dangerous measures of an operator's performance. The need to identify GTFPvkm as an aid in interpreting and qualifying the changed relativities of GTFPpass is seen in the Transperth case. The discussion of the partial ratios in Table 13.7 also assist in interpreting the ranking.

Third, the discussion on the merits of having both a demand-side and a supply-side measure of output used in the calculation of GTFP is further highlighted with operator M5. This operator performs very poorly on GTFPpass (rank = 32) because of the specialised nature of passengers – a small number of disabled children being transported over long distances by specially fitted out buses. The low levels of patronage suggest poor performance, although M5 is ranked 22 out of 32 in the way inputs are used to produce vehicle kilometres. Two other private operators who have much better performance on GTFPpass (S4 and M3) are worse than M5 on TFPvkm.

Finally, in any comparison of the rankings of each operator it is important to identify the actual level of the TFP index, because some of the operators have indices with very similar values. For example, Brisbane Transport and Transperth have TFPvkms 56.48 and 56.07, respectively. Transperth and Metro's TFPpass indices are 26.29 and 26.92, respectively:

It does not take a very large change in output or inputs to change the adjacent rankings.

It is important to recognise this point and to allow for some degree of 'grouping' of operators with very similar TFP indices in any interpretation of the findings.

13.5.2.3. Comparative Assessment after Adjusting for Scale and Other Effects

The adjusted TFP indices after allowing for scale and other sources of variation in GTFP are given in Table 13.8. The change in rank order after adjusting for scale (identified by the bracketed rank in Table 13.8 only) is of most interest. The larger public operators loose rank except for the PTC

Table 13.8. Summary of GTFP, Scale-adjusted GTFP and Residual TFP Indices, 1991/1992.

Operator	TFPpass						TFPvkm					
	Gross TFPpass	Rank	Scale-adjusted	Rank	Residual TFPpass	Rank	Gross TFPvkm	Rank	Scale-adjusted	Rank	Residual TFPvkm	Rank
NSW												
S1	1.647	6	1.516	5	0.267	12	1.691	6	1.437	6	0.539	7
S2	1.488	9	1.342	9	0.042	21	1.427	15	1.147	15	0.210	21
S3	0.626	31	0.540	28	−0.053	26	0.952	30	0.760	25	0.211	20
S4	1.039	15	0.954	15	0.431	6	1.085	23	0.933	23	0.226	19
S5	1.805	4	1.698	4	0.187	15	1.884	1	1.683	1	0.848	1
S6	1.960	3	1.805	3	0.150	18	1.646	8	1.360	9	0.550	6
S7	2.429	1	2.275	1	0.768	2	1.674	7	1.409	7	0.198	22
S8	2.307	2	2.167	2	0.777	1	1.511	10	1.284	12	0.248	17
S9	1.584	7	1.478	6	−0.085	29	1.697	4	1.495	4	0.610	5
S10	0.930	18	0.805	19	−0.276	31	1.468	13	1.185	14	0.084	25
S11	1.023	16	0.954	16	−0.172	30	1.735	2	1.571	2	0.803	2
S12	1.552	8	1.426	8	0.395	7	1.228	19	1.011	18	0.349	13
Average in Sydney	1.615	–	1.413	–	0.226	–	1.596	–	1.273	–	0.444	–
QLD												
B1	1.144	13	1.144	12	0.304	10	1.486	12	1.379	8	0.772	4
B2	0.673	27	0.604	26	0.094	20	1.490	11	1.299	10	0.745	3
B3	0.810	23	0.698	20	0.318	9	1.732	3	1.450	5	0.233	18
B4	0.626	30	0.545	27	0.166	17	1.208	20	1.000	19	0.186	23
B5	0.726	26	0.628	24	0.433	5	1.271	17	1.038	17	0.469	10
B6	1.186	12	1.056	13	0.244	13	1.570	9	1.294	11	0.307	16
Average Brisbane	0.861	–	0.779	–	0.260	–	1.460	–	1.243	–	0.452	–

Table 13.8. *(Continued)*

Operator	TFPpass								TFPvkm			
	Gross TFPpass	Rank	Scale-adjusted	Rank	Residual TFPpass	Rank	Gross TFPvkm	Rank	Scale-adjusted	Rank	Residual TFPvkm	Rank
VIC												
M1	1.378	10	1.301	10	0.595	3	1.252	18	1.132	16	0.468	11
M2	0.906	19	0.824	18	0.146	19	1.443	14	1.254	13	0.418	12
M3	1.255	11	1.184	11	−0.071	25	1.074	24	0.973	20	0.328	14
M4	1.014	17	0.852	17	0.186	16	1.318	16	0.973	21	0.141	24
M5	0.370	32	0.325	32	0.212	14	1.105	22	0.937	22	0.508	9
M6	1.111	14	1.038	14	0.491	4	1.695	5	1.530	3	0.517	8
Average in Melbourne	1.006	–	0.921	–	0.270	–	1.315	–	1.133	–	0.397	–
Average in private	1.233	–	1.132	–	0.234	–	1.443	–	1.231	–	0.415	–
Public												
STA (NSW)	1.735 [1]	5	1.435 [1]	7	0.033 [3]	22	1.034 [4]	27	0.458 [7]	31	−0.30 [4]	28
Action	0.735 [6]	25	0.527 [6]	29	−0.500 [8]	32	0.955 [6]	29	0.506 [6]	30	−0.19 [2]	26
PTC	0.844 [4]	22	0.635 [3]	22	0.361 [1]	8	1.020 [5]	28	0.578 [2]	26	−0.33 [7]	29
BCC	0.899 [2]	20	0.666 [2]	21	0.033 [4]	23	1.064 [2]	25	0.566 [3]	27	−0.37 [5]	30
STA (SA)	0.866 [3]	21	0.617 [5]	25	0.004 [5]	24	0.944 [7]	31	0.422 [8]	32	−0.56 [8]	32
Transperth	0.638 [8]	29	0.399 [8]	31	−0.057 [6]	27	1.056 [3]	26	0.513 [5]	29	−0.41 [6]	31
Metro	0.654 [7]	28	0.477 [7]	30	−0.084 [7]	28	0.930 [8]	32	0.542 [4]	28	−0.19 [2]	26
DBS	0.744 [5]	24	0.635 [4]	23	0.290 [4]	11	1.136 [1]	21	0.889 [1]	24	0.31 [1]	15
Average in public	0.889	–	0.674	–	0.010	–	1.017	–	0.559	–	−0.254	–
Average in all	1.147	–	1.018	–	0.178	–	1.337	–	1.063	–	0.248	–

Note: In making statements about the relative efficiency and effectiveness of operators, the important comparison is scale-adjusted TFP. [ ] is rankings within public operators.

whose rank order remains unchanged. M5, the 'Melbourne outlier', remains as the least productive on TFPpass, due predominantly to its specialised service for the disabled. While such a comparison may be in the 'apples and oranges' classification, it nevertheless does demonstrate the disproportionately high level of inputs used to service specialised passenger markets (as is also demonstrated by operators who have a sizeable coach operation attached to an urban bus service). Overall, the loss of TFPpass rank of public operators is transferred to four of the six Brisbane private operators – the effect on the ranking of the private Sydney and Melbourne operators is negligible except for S3. Thus, after adjusting for scale as defined by patronage, the Sydney private operators still retain their strong position and the Brisbane private operators improve within the lower two quartiles.

The distinction between GTFP or Scale adjusted TFP and ResidualTFP is very important. Where an operator has a relatively high GTFP or scale-adjusted TFP but a relatively low ResidualTFP, we have captured a substantial amount of the explanation for the relative scale-adjusted or GTFP level. A low ResidualTFP relative to the original GTFP must not be interpreted to mean poor productivity. It simply says that *relative to the GTFP index*, that there are few remaining unexplained influences on TFP. All absolute values of ResidualTFP are substantially smaller than the GTFP. What is, however, of greater interest is the adjusted ranking. If the ranking drops substantially it indicates that the observed influences operate in favour of other operators relative to the operator being evaluated. A preserved high ranking indicates that there are a number of unobserved influences on relative productivity, which favour an operator relative to other operator.

The change in rank order between GTFP and ResidualTFP and the implications this has on the overall quartile profile in Table 13.6, is summarised in Table 13.9. The changing rank order is much more noticeable after

Table 13.9. Quartile Incidence of Group Membership: GTFPpass vs. Residual TFPpass and GTFPvkm vs. Residual TFPvkm (residual TFP in parentheses for TFPpass and TFPvkm, respectively).

Quartile (Q)	Private Sydney		Private Brisbane		Private Melbourne		Public	
	TFPpass	TFPvkm	TFPpass	TFPvkm	TFPpass	TFPvkm	TFPpass	TFPvkm
1st Q (1–8 rank)	7 (4)	6 (5)	0 (1)	1 (2)	0 (2)	1 (1)	1 (1)	0 (0)
2nd Q (9–16 rank)	3 (2)	3 (1)	2 (3)	3 (2)	3 (2)	2 (4)	0 (1)	0 (1)
3rd Q (17–24 rank)	1 (2)	2 (5)	1 (2)	2 (2)	2 (1)	3 (1)	4 (3)	1 (0)
4th Q (25–32 rank)	1 (4)	1 (1)	3 (0)	0 (0)	1 (1)	0 (0)	3 (3)	7 (7)
Total	12		6		6		8	

the statistically significant sources of influence on scale-adjusted TFP are netted out. On TFPvkm, 10 of the private operators and 3 of the public operators drop in rank, while 11 private and 4 public operators improve in rank. On TFPpass, 10 of the private operators and 3 public operators have dropped in rank, while 13 private and 5 public operators have improved in rank. This is to be expected, given that we have now identified some particularly strong effects, which work in favour of particular operators and against other operators in a relative sense. A careful assessment of each operator suggests that the two top operators on TFPpass (S7 and S8) and TFPvkm (S5 and S11) have remained in the top two, which suggests that the set of unobserved sources of variation in ResidualTFP are still strongly supporting these two operators even after allowing for the influences in Table 13.7.

There have been some dramatic changes in rank order, which highlight the fact that for some operators we have identified the factors which largely define their strong or weak ranking relative to other operators. For example, operator S7 who is ranked number 7 on GTFPvkm and scale-adjusted TFPvkm has dropped to rank 22 on ResTFPvkm (while still retaining the number 2 rank on TFPpass). Much of the productivity advantage S7 has is attributable to fleet utilisation (see Table 13.1, no coaches, 20% employment of casuals, and relatively low non-labour overheads per vehicle kilometre.

In conclusion, the evidence suggests that there is a scale and scope effect, which reduces the advantage that the larger public operators have on this dimension. However the influence of other factors continues to dominate in the explanation of the sources of difference between operators, especially between private and public operators, and within the private operators, between the Sydney, Melbourne and Brisbane operators.

13.6. CONCLUDING COMMENTS

This chapter has developed and applied a procedure for quantifying the productivity of each public bus operator and a sample of private bus operators in urban Australia for the period 1991/1992. The data have been compiled from a survey undertaken in 1993, which sought detailed information on the profile of each operator with respect to patronage, revenue, input quantities and expenditures, and contextual variables such as location, ownership and institutional environment. The 32 operators represent operators receiving varying degrees of subsidy support (including no such support), and who vary on important dimensions such as physical size, location, market structure, patronage opportunities, activity composition, network configuration and management structure. These empirical dimensions are the essence of sources of variation in performance.

The indicators of productivity quantified herein are one of a number of alternative ways of empirically measuring cost efficiency and cost effectiveness, and in identifying sources of differences across operators. The results provide very strong evidence on the relative productivity of operators in the private and public sector operating under varying institutional and regulatory regimes.

Berechman (1993) provides a detailed assessment of the transit industry. In evaluating the evidence on the relationship between regulation and transit productivity, he states that although very few studies have investigated this question directly

> it is possible to conclude that regulation has resulted in inefficient utilisation of resources, mainly labour in public transit. Moreover, the presence of regulatory constraints on earnings, due to fare and output control, has led to inefficient service provision, making it impossible for transit firms to achieve cost minimisation .... Another result of regulation is the inability of transit firms to reduce route miles in the face of declining demand ... this inability of transit firms to properly adjust their produced output and fleet size has contributed rather significantly to a decline in the average density of service and, consequently, to falling productivity levels (pp. 172–173).

The spirit of these findings are embedded in the evidence, now before us, for Australia.

This page intentionally left blank

CHAPTER 14

A SERVICE QUALITY INDEX FOR AREA-WIDE CONTRACT PERFORMANCE ASSESSMENT[§]

14.1. INTRODUCTION

Suggestions that we need to be more vigilant in the way that service quality is handled in contracts has often led to concerns about adding complexity to contract design that would both discourage bidders and add unacceptable administrative costs to the evaluation and monitoring process. The extent to which required service-quality targets would discourage bidders and/or add administrative costs will be dependent on how complex the service-quality formula becomes and the extent to which it adds to the incentive (in)compatibility of the tendering process.

While cost efficiency gains are very important in the establishment of a successful competitive bid, the definition preconditions the outcome on a given level of service. Such a (minimum) service level exists in New South Wales is defined by the amount of service kilometres and hours delivered over a network subject to conditions on access distance to the network.[133] This definition of service level does not take into account what really influences a user's perception of the effectiveness of a service.

This chapter proposes a way of measuring service quality that results in an intuitively appealing formula that is transparent, is incentive compatible, easy to administer and monitor and which can be integrated into the specification of a competitive tender.[134] Although the focus herein is on how one might develop and introduce a service quality index (SQI) into competitive contracts, it can also have great value in any competitive or monopoly regime as a mechanism for knowing ones business better. In developing such

[§]This chapter first appeared as an article in the *Journal of Transport Economics and Policy*.

a SQI we integrate the rich literatures on stated choice methods and performance measurement, redefining service effectiveness to reflect the importance of perceived service quality from a users' perspective.

The inclusion of service quality opens up an opportunity to review the way that competitive tenders are structured to take into account improved service quality in line with benchmarked best practice. In addition to requiring the delivery of a specific level of service, we might include a requirement to provide this level of service to comply with a target service quality as specified by SQI. One possible strategy is to inform bidders about the current level of service quality on *each* of the dimensions of the SQI (together with the weights for each attribute) and to require that the successful bidder move the index up to a new level by adjusting the levels of one or more of the attributes in the index (see below). The operator can determine how to achieve the target level and what it might cost and build this cost into the price of the bid. In this way, we are encouraging improvements in service quality under incentive compatible tenders.

This chapter is organised as follows. We begin with a review of approaches to specify an indicator of service quality. This is followed by the justification for the SP paradigm with a focus on evaluating packages of service attributes. The empirical context and survey instrument are presented followed by the analysis results from a multinomial logit model and the construction of the SQI. The final section preceding the conclusion suggests a schema for integrating SQI into the specification of a competitive tender, including the determination of targets and conditions of review and renewal.

14.2. THE SEARCH FOR AN OPERATIONAL INDICATOR OF SERVICE QUALITY

The literature on measuring the cost efficiency and cost effectiveness of bus services and operations is extensive (e.g., Fielding et al., 1985; Hensher & Daniels, 1995). A major data input is the level of service output, typically measured on the demand side by annual passenger trips or passenger kilometres and on the supply side by vehicle kilometres. As aggregate indicators of total output, these measures implicitly assume homogeneity in respect of service quality. Passengers, however, evaluate services in many ways, which may not be systematically associated with the amount of use of the service; indeed it is unclear whether differences in passenger satisfaction across the segments served by buses can be proxied by the preferred demand-side indicator, aggregate passenger kilometres.

In the 1970s, British rail argued that maximisation of passenger kilometres was a good proxy indicator of social welfare maximisation and accessibility offered to passengers. At the time, however, there had not been any substantive investigation of how passengers perceive the level and quality of services in their determination of passenger satisfaction. A number of studies have since refocussed on the measurement of service quality, investigating the role of trade-off methods such as SP (e.g., Hensher, 1991; Swanson, Ampt, & Jones, 1997) and univariate procedures that rate individual service items on a satisfaction scale (e.g., Cunningham, Young, & Lee, 1997).

Although specific aspects of service quality may be particularly positive or negative in a passenger's perception of (and satisfaction with) a service, we make the assumption that the overall level of passenger satisfaction is best measured by how an individual evaluates the total package of services on offer. Appropriate weights attached to each service dimension will reveal the strength of positive and negative sources of overall satisfaction. The SP paradigm enables us to develop preference formulae for a large number of service-level scenarios, which can be implemented at the bus business level to establish operator-specific indicators of service delivery quality and effectiveness. The resulting satisfaction (or utility) indicators emanating from the estimation of the SP experiments measure the expected utility that a passenger obtains from the current levels of service and how this might change under alternative service level regimes.[135]

14.3. THE STATED PREFERENCE PARADIGM

The task is to develop an approach to incorporating a service quality indicator into a performance assessment regime that is a meaningful measure of service effectiveness from a passenger perspective. In addition, such an index should have the ability to be decomposed into its constituent sources of passenger satisfaction, as well as mapping into an aggregate demand-side indicator of passenger output to establish the role of the latter as a practical approximation of the social welfare significance of the bus service levels.

The starting position is a recognition that passengers purchase a package of service attributes when travelling on a bus, and thus the contribution of each underlying elemental attribute must be assessed in the context of the overall quality of service on offer. With a complex disaggregation of service quality, RP data is usually inappropriate. There is often too much confoundment in RP data, best described as 'dirty' from the point of view of statistical estimation of the individual influences on choice. Furthermore, some attributes such as air conditioning do not exist today on many urban buses so we are unable to establish their influence.

Stated preference (SP) methods are now well accepted in the transport research community and increasingly used in practical applications (see Louviere, Hensher, & Swait, 2000, for a review). They provide the richness required for the SQI through a stated choice experiment in which we systematically vary combinations of levels of each attribute to reveal new opportunities relative to the existing service levels on offer. Through the experimental design paradigm we observe a sample of travellers making choices between the current trip attribute level bundle and other attribute level bundles. This approach is capable of separating out the independent contributions of each service component (even while recognising that in reality such attributes are often correlated), and hence is capable of providing an SQI that is a rich representation of the sources of service (dis)utility.

14.4. DEFINING THE EMPIRICAL SETTING AND THE SP EXPERIMENT

To assist in the selection of attributes for SQI, we undertook an extensive review of the literature as well as a survey of bus operators who have a wealth of experience on what customers look for in a good service (see Prioni & Hensher, 1999). We found that 13 attributes describe the major dimensions of service quality from a user's perspective.[136] The range of levels of each attribute in Table 14.1 provided us with a mechanism for establishing the weights that signal the contribution of each attribute to the overall SQI.

Through a formal statistical design the attribute levels are combined into *bus packages* before being translated into a survey form. The full-factorial design (i.e., all possible bus packages) consists of 3^{13} combinations of the 13 attributes each of three levels.[137] To produce a practicable and understandable design for the respondents, we restricted the number of combinations to 81 (i.e., 81 choice sets) using a fractional design. Fractional designs permit the reduction in the number of combinations (i.e., the number of bus packages) without losing important statistical information (see Louviere, Hensher, & Swait, 2000).

A pre-test of the survey showed that respondents were able to evaluate consistently three choice sets (i.e., different scenarios of bus packages), each

Table 14.1. The Set of Attributes and Attribute Levels in the SP Experiment.

Attribute	Interpretation of Levels	Attribute	Interpretation of Levels
Reliability	– On time – 5 min late – 10 min late	Info at the bus stop	– On time – 5 min late – 10 min late
Frequency	– Every 15 min – Every 30 min – Every 60 min	Travel time	– 25% Quicker than the current travel time – Same as now – 25% Longer than the current travel time
Walking distance to the bus stop	Now – 5 min more – 10 min more	Bus stop facilities	– Bus shelter with seats – Seats only – No shelter or seats at all
Waiting safety	– Very safe – Reasonably safe – Reasonably unsafe	Fare	– 25% more than the current one-way fare – Same as now – 25% less than the current one-way fare
Access to the bus	– Wide entry with no steps – Wide entry with two steps – Narrow entry with four steps	Driver attitude	– Very friendly – Friendly enough – Very unfriendly
Air conditioning	– Available with no surcharge – Available with a surcharge of 20% on existing one-way fare	Safety on board	– The ride is very smooth with no sudden braking – The ride is generally smooth with rare sudden braking – The ride is jerky; sudden braking occurs often
Cleanliness of seats	– Not available – Very clean – Clean enough – Not clean enough		

with three alternatives, resulting in 27 different survey forms from the 81 choice sets. To allow for a rich variation in the combinations of attribute levels to be evaluated as service packages in the SP experiment, each bus operator received eight sets of 27 different survey forms (i.e., 216 forms) and instructions on how to organise the survey. An example of an SP question is shown in Table 14.2. Each passenger was given a survey form on-board and asked to complete it and return it either at the end of the trip or at another time.[138] The form was two-sided (A4) with information on the current trip on the first side and some socioeconomic questions, with the three SP choice sets on the second page.

14.5. RESULTS OF THE USER PREFERENCE MODEL

Scheduled[139] bus users of 25 private bus operators in NSW participated. Survey forms were distributed and collected during April and May 1999. A total of 3,849 useable observations (out of 4,334 returns) were incorporated in the estimation of the discrete choice model, producing 11,547 cases in model estimation. A multinomial logit (MNL) specification was selected.[140] All design attributes were generic across the three alternatives, consistent with the attribute-abstract nature of the SP experiment. In addition in the current trip alternative we considered alternative-specific characteristics of the passenger (income, gender, age and car availability) and of the operator together with a number of other potential influences on relative utility such a treatment effect, trip purpose and access mode.

The user attribute choice model is summarised in Table 14.3. The model includes the attributes of the SP experiment, operator-specific dummy variables and three user characteristics. The overall goodness of fit (adjusted pseudo-R^2) of the model is 0.324.[141] The great majority of the design attributes are statistically significant. Service reliability (i.e., the extent to which buses arrive on time), fares, access time and travel time are all highly significant with the expected negative sign. Relative to ‘reasonably unsafe’, we find a positive (almost) significant parameter estimate for ‘reasonably safe’ (0.1510) and for ‘very safe’ (0.1889). The higher estimate for ‘very safe’ in contrast to ‘reasonably safe’ is plausible. The infrastructure at the bus stop appears to not be a major influence on service quality with both ‘seats only’ and ‘bus shelter with seats’ not being statistically significant relative to ‘no shelter or seats’. If reproducible in further studies this has important policy implications as to priorities in service improvement.

Table 14.2. A Typical Stated Preference Exercise.

Service Feature	Bus Package of the Bus Company A	Bus Package of the Bus Company B	Bus Package of the Current Bus
Reliability	10 min late	On time	7 min late
One-way fare	Same as now	Same as now	2 dollars
Walking distance to the bus stop	5 min more than now	5 min more than now	5 min
Personal safety at the bus stop	Reasonably unsafe	Reasonably safe	Very safe
Travel time	25% longer than the current travel time	25% quicker than the current travel time	30 min
Bus stop facilities	No shelter or seats at all	Seats only	Seats only
Air conditioning	Not available	Available with no surcharge	Not available
Information at the bus stop	Timetable but no map	Timetable but no map	Timetable and a map
Frequency	Every 15 min	Every 30 min	Every 60 min
Safety on board	The ride is jerky; sudden braking occurs often	The ride is jerky; sudden braking occurs often	The ride is jerky; sudden braking occurs often
Cleanliness of seats	Clean enough	Clean enough	Very clean
Ease of access to the bus	Wide entry with no steps inside the bus	Wide entry with two steps inside the bus	Wide entry with two steps inside the bus
Driver behaviour	Friendly enough	Very friendly	Very friendly

If Bus A and Bus B were available today, which bus service would you choose?
☐ Bus A ☐ Bus B ☐ The bus you are travelling on.

Table 14.3. Final User Preference Model.

Variable	Units	Acronym	Parameter	*t*-Value
Reliability	Minutes	RELI	−0.05821	−8.411
Bus fare	Dollars	TARIF	−0.4780	−6.406
Access time	Minutes	ACCESST	−0.04317	−5.311
Bus time	Minutes	TRATIM	−0.03200	−5.435
Very safe	1,0	VSAFE	0.18895	2.255
Reasonably safe	1,0	RSAFE	0.15108	1.820
Seats only at bus stop	1,0	SEATS	−0.03411	−0.510
Seat plus shelter	1,0	SEATSHEL	0.09040	1.503
Air conditioning free	1,0	AVALFREE	0.07131	1.112
AC at 20% extra fare	1,0	AVALPAY	−0.17432	−2.207
Ride –generally smooth	1,0	GSBRAKE	0.20788	2.963
Ride very smooth	1,0	VSNBRAKE	0.35232	4.904
Clean enough	1,0	CENOUGH	0.13867	1.830
Very clean	1,0	VCLEAN	0.20446	2.713
Wide entry/two steps	1,0	WIDE2STP	0.09589	1.499
Wide entry/no steps	1,0	WIDENSTP	−0.10319	−1.372
Driver friendly enough	1,0	FRIENDEN	0.19798	2.572
Driver very friendly	1,0	VFRIEND	0.42287	5.564
Timetable only	1,0	TIMNOMAP	0.29609	4.745
Timetable and map	1,0	TIMWMAP	0.19720	3.021
Frequency/every 60 min	1,0	FREQ60	−0.58595	−6.902
Frequency/every 30 min	1,0	FREQ30	−0.12221	−1.640
Female	1,0	FEMALE	0.09986	1.198
Personal income	$'000s	PINCO	0.00905	3.817
Age of passenger	Years	AGES	0.01379	5.787
Operator 1	1,0	Op1	0.37358	1.671
Operator 2	1,0	Op2	0.19642	0.654
Operator 3	1,0	Op3	−0.94098	−5.497
Operator 4	1,0	Op4	−0.17726	−1.080
Operator 5	1,0	Op5	−0.12964	−0.653
Operator 6	1,0	Op6	0.97267	1.937
Operator 7	1,0	Op7	−0.18127	−0.982
Operator 8	1,0	Op8	0.35723	1.294
Operator 9	1,0	Op9	−0.26210	−1.215
Operator 10	1,0	Op10	−0.56626	−1.845
Operator 11	1,0	Op11	−1.2555	−4.850
Operator 12	1,0	Op12	−0.22189	−0.842
Operator 13	1,0	Op13	−0.47366	−1.210
Operator 14	1,0	Op14	0.01784	0.072
Operator 15	1,0	Op15	0.06911	0.084
Operator 16	1,0	Op16	−0.37973	−1.685
Operator 17	1,0	Op17	0.06878	0.292
Operator 18	1,0	Op18	−0.36574	−0.825
Operator 19	1,0	Op19	1.1207	4.218

Table 14.3. (*Continued*)

Variable	Units	Acronym	Parameter	t-Value
Operator 20	1,0	Op20	0.10014	0.488
Operator 21	1,0	Op21	0.11275	0.546
Operator 22	1,0	Op22	0.32239	0.781
Operator 23	1,0	Op23	−0.53292	−1.845
Operator 24	1,0	Op24	0.08878	0.161
Log-likelihood	−2839.25			
Pseudo R^2 (adjusted)	0.324			

The availability of air conditioning is another interesting result. We find that 'air conditioning without a fare surcharge' is not statistically significant relative to no air conditioning. In contrast, the provision of air conditioning with a 20% surcharge on existing fares is statistically significant with a negative sign suggesting that users would sooner not have air conditioning if it means paying higher fares.

On-board safety, defined by the smoothness of the ride, is a statistically strong attribute. Relative to 'the ride is jerky with sudden braking occurring often', we find that 'the ride is generally smooth with rare sudden braking' and 'the ride is smooth with no sudden braking' are both very important positive attributes of service quality. This suggests both policy initiatives in driver skill as well as vehicle quality. Cleanliness of the bus is statistically significant when 'very clean' relative to 'not clean enough'. The non-statistical (1.830) significance of 'clean enough' suggests that we really have a dichotomy between very clean and not very clean. Ease of access to a bus, closely linked to the issue of accessible transport turns out to be not so important overall, presumably because the majority of users (including many ageing users) are sufficiently healthy to not to be concerned with the configuration of steps and entry widths. The attitude of the driver is a statistically strong influence on a user's perception of service quality. Indeed, relative to 'very unfriendly' we might expect a significant increase in the mean parameter estimate when we go from 'friendly enough' to 'very friendly'. Finally, the availability of information at the bus stop (timetable and map) is statistically important compared to 'no information', although surprisingly the key information item is a timetable, with a map being a liability (possibly because of experience with vandalism?).

Finally, bus frequency defined as 15, 30 and 60 min was found to be significant when treated as a dummy variable distinguishing 60 min from 15 and 30 min. There is a strong negative sign for the 60 min dummy variable suggesting that a 60 min service reduces relative utility significantly compared with a service frequency of every 15 or 30 min. Not statistically significant is the 30 min dummy variable, defined equal to one for frequencies equal to 30 min.

The socioeconomic characteristics sought from bus users were limited to personal income, age, gender and car availability. We found that individuals on higher incomes and of more years were more likely to prefer the levels of service offered by the existing trip than by the alternative packages. What this suggests is that as individuals age and increase their income, they see existing service quality as increasingly satisfying their requirements for service quality. Alternatively, it is the younger and those on lower incomes that see a greater need for improved service quality. Car availability was not statistically significant. We investigated the potential for systematic bias due to the sequence in which the SP treatments were given on the survey instrument. We were not able to find any evidence of bias in selection from the current and two alternative service packages. We also analysed possible effects of the survey administration since a range of data collection procedures were implemented across the 25 operators. For example, drivers were involved in the forms distribution in some cases, while inspectors were involved in some other instances. A series of dummy variables were introduced distinguishing distribution and collection by (i) the driver, (ii) an inspector who stayed on board and explained the survey and (iii) an inspector handing out forms with a reply post-paid envelope to return the forms at a later date. The distribution and collection procedure was not a statistically significant influence on the choices made by respondents, despite the ex ante suggestion from some bus operators that the responses would be systematically biased (in favour of current service) by an approach which may appear to be coercing passengers to participate.

Trip purpose, with the exception of commuting, did not statistically impact on the choice, while commuting was marginally significant. With 25 bus operators we have 24 operator-specific effects. These effects account for *other* influences on choice that are unique to each operator. A negative sign on the parameter estimate implies that a bus operator is perceived by users as delivering a quality of service that is, relative to the base operator, worse. By comparing the absolute magnitude of the parameter estimate we can see the extent to which an operator is delivering a service that is worse than other operators after allowing for the attributes explicitly taken into account from the SP experiment. Operators 3 and 11 have the highest negative operator-specific parameter estimates while operators 1, 6 and 19 have the highest positive operator-specific estimates (further details are given in Prioni & Hensher, 2000).

14.6. THE SERVICE QUALITY INDICATOR (SQI)

The SQI for each operator is calculated by the application of the utility expression in Table 14.3 and the levels of each of the attributes associated with the current trip experience of each sampled passenger.

The SQI developed for each operator is summarised in Table 14.4 and graphed in Fig. 14.1 at its mean for each operator. We have normalised SQI in Fig. 14.1 to a base of zero for the operator with the lowest relative SQI. The range is from 0 to 2.70.

In developing the SQI indicator we have taken into account the differences in the socio-economic composition of the travelling public (i.e., age, personal income and gender).[142] The contribution of each service-quality attribute across all 25 operators in summarised in Fig. 14.1 (and defined in Table 14.4).

Table 14.4. Summary Statistics of Service Quality Index.

Operator	Mean	Standard Deviation	Minimum	Maximum	Sample Size
1	0.5311	0.788	−2.39	2.28	249
2	0.3900	0.894	−1.87	2.00	96
3	−0.8178	1.248	−4.88	1.92	508
4	−1.098	0.927	−5.58	0.58	374
5	−1.2840	1.406	−5.46	0.84	196
6	−0.8377	0.383	−0.525	0.80	24
7	−0.9263	1.297	−6.74	1.82	412
8	−0.7113	0.566	−2.12	0.44	150
9	−0.4597	0.685	−2.55	1.06	173
10	−0.5805	0.904	−3.06	0.67	64
11	−1.628	0.979	−4.55	0.55	90
12	−0.3923	1.000	−3.80	1.40	100
13	0.5435	0.483	−0.434	1.28	41
14	0.7636	0.940	−2.28	2.61	180
15	0.2079	0.637	−0.638	0.692	9
16	−0.6345	0.958	−4.00	1.03	159
17	−0.0649	1.089	−2.86	2.09	190
18	−0.5687	1.206	−3.24	1.04	27
19	1.0174	0.947	−0.990	2.70	203
20	−0.0444	0.639	−1.43	1.55	224
21	−0.4212	0.852	−3.45	1.17	227
22	0.6466	0.643	−0.600	2.01	46
23	−0.3076	1.034	−4.28	0.808	65
24	0.1051	1.156	−2.17	1.42	22
25	−1.7579	0.875	−3.01	−0.096	20
All	−0.4067	1.224	−6.74	2.70	3849

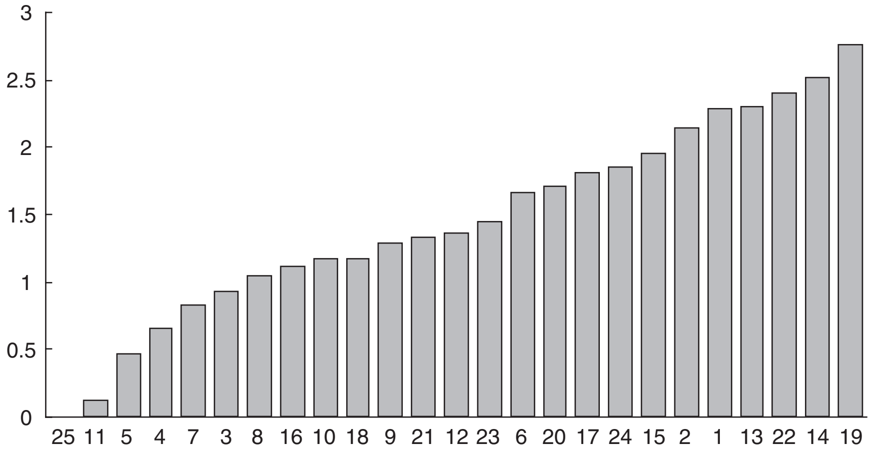


Fig. 14.1. The Service Quality Index.

The challenge for an operator is to compare themselves against best practice and to establish how best to improve overall service quality through implementing changes that reduce the magnitude of the attributes below the zero axis in Fig. 14.2 and increase the magnitude of attributes above the zero axis.

14.7. OPERATIONALISING SQI AS A REGULATORY TOOL

14.7.1. Integrating SQI Targets in the Specification of Tenders

A growing criticism of competitive tendering is that economic regulators have failed to build into the specification of tender documents information on the quality of incumbent services from the users' perspective. This gap in the tendering process denies potential bidders the opportunity to prepare their bid offers with full knowledge of the effectiveness of existing service levels (Domberger et al., 1995; Van de Velde & Sleuwaegen, 1997).

SQI provides an appealing index to compute and operationalise service quality from an user perspective in an easy and scientific way. Because of its simplicity and its ability in capturing the important user-defined service quality component in a single index, SQI has appeal as an operational tool in the specification of tendering contracts. SQI makes explicit through the

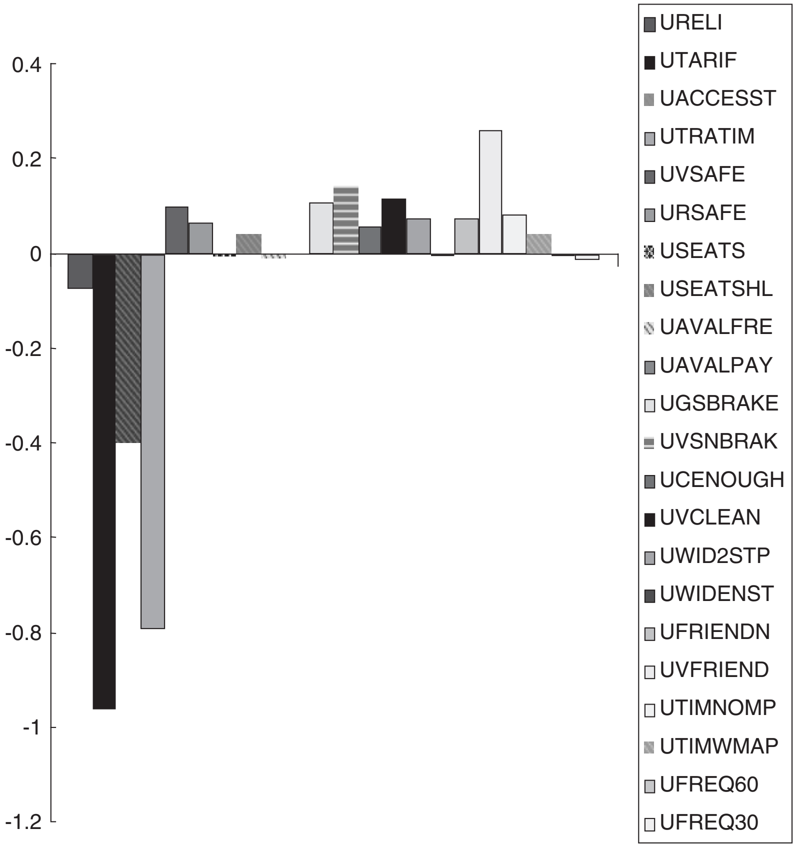


Fig. 14.2. The Composition of the Service Quality Index (All Operators in the Sample).

revelation of information on current service quality the requirement to take into account the cost of maintaining and even enhancing service quality in bid offers, minimising the selection of low bids accompanied by low service quality delivery. In time, SQI could provide the basis for establishing minimum standards for different aspects of service quality in the contract (a preferred basis for deriving such standards) Table 14.5.

An identification of SQI prior to tendering would allow the responsible authority to gain information on customers' satisfaction with the current levels of service quality and to include this information in the form of service quality targets in the contract specification.

Table 14.5. Notation for Figure 14.1.

URELI	Late minutes	UVSNBRAKE	Ride very smooth
UTARIF	Bus fare	UCENOUGH	Clean enough
UACCESST	Access time	UVCLEAN	Very clean
UTRATIM	Travel time	UWIDE2STP	Wide entry and two steps
UVSAFE	Very safe	UWIDENSTP	Wide entry no steps
URSAFE	Reasonably safe	UFRIENDN	Friendly drivers
USEATS	Seats only at bus stop	UVFRIEND	Drivers very friendly
USEATSHEL	Seats plus shelter at stop	UTIMWMAP	Timetable and map
UAVALFREE	Free Air conditioning	UTIMNOMAP	Timetable, no map
UAVALPAY	Air conditioning at 20% extra fare	UFREQ60	Frequency 60 min
UGSBRAKE	Smooth ride	UFREQ30	Frequency 30 min

Table 14.6. Including SQI Targets in the Contact Design.

Operator	Current Service Description					SQI		
	Attributes						Target after	
	Reliability	Bus fare	Clean enough	Travel time (min)	Etc.	Realised	2.5 years	5 years
1	2 min late	2.1	60%	25	…	1.4	1.6	1.8
2	1 min late	2.4	78%	26	…	1.3		
3	1 min late	2.0	80%	21	…	2.0		

Table 14.6 gives an example on how one might integrate SQI targets into the tender process. Let us assume that from a survey of a sample of existing users, we have identified the user-defined quality of current service of three operators. Operator 1 achieved an SQI of 1.4 by providing a service that is on average two minutes late, clean enough for 60% of the sampled users, costs on average $2.1, etc. Operators 2 and 3 have SQI's 1.3 and 2.0, respectively. Assuming that these operators are comparable, Operator 3 is best practice.

Regulators can use the SQI in the contract design to specify how much service improvement they require relative to the current levels as illustrated in the last two columns of Table 14.6.[143] Although one might impose the requirement that each and every bus operator must be at best practice, this may discourage bidders and so we prefer to set a target level that is recognised as achievable by potential bidders. The level should be incentive compatible.

Given the gap between an operator's SQI and that of best practice (e.g., 0.6 for operator three), we suggest a formulation SQI+z where z is the predesignated improvement over a period of time (e.g., 0.2 in both sub periods). The SQI + z formula provides a target in line with a pre-designated increase in the service quality level. In the case of the service previously provided by incumbent operator one, authorities impose an SQI target of 1.6 after 2.5 years and a final SQI target of 1.8 at the end of the contract (5 years).

An important issue is the acceptability of this target by operators and the processes they need to put in place to move towards the target. To understand this challenge, the authors held a three-hour debriefing with all the operators. The approach was received with great enthusiasm and (to our surprise) was readily seen as a way forward. We were also invited to present the approach and evidence to three of the larger operator's boards.[144] The ability to identify the contribution of each attribute to SQI was seen as a way to track service delivery that had never been available before, and that it offers many ways of improving SQI without a specific mandate from the regulator. This flexibility was a major selling point. Indeed, Fig. 14.2 became the basis of much board-level discussion – clearly an important decision-support tool.

We must recognise that best practice will change over time, and hence the target will be revised. Such a revision can be used to reset the value of z for the next 2.5 years (in our example) and not backdated. In practice, all potential entrants must be provided with the computational formula for SQI. According to their managerial and operational capability they will decide on how to decompose the index into the individual attribute components to achieve the targeted SQI. For example, an operator might prefer to put more effort into the cleanliness of the vehicles and less into the reliability attribute (due to the difficult traffic conditions), but still comply with the targeted SQI. SQI is not designed to provide strict guidance on what measures an operator must put in place to improve SQI (i.e., the mapping between supply change and passenger perception of service quality); rather its whole purpose is to provide a framework within which an operator is free to investigate ways of improving service levels that map into improvements in SQI. Overtime, operators will come to learn by experience what produces a deliverable improvement in service, and hence SQI.

The required service quality level will be evaluated by bidders and added into the cost of providing the higher level of service to determine the bid price. The contract will be awarded to the lowest price offer (with the cost of service quality internalised-what might be referred to as the *effective price*). Once successful in winning the contract the operator has a strong incentive to meeting the new levels of service. Compared to most tender contract specifications, the inclusion of SQI in the contract secures improvements in cost efficiency while meeting the new levels of service effectiveness as prescribed by a user-defined service index.

14.7.2. Establishing the Actual Target

There are no specific arguments for establishing a particular SQI target other than to ensure an incentive compliant tendering process. The success of competitive tendering is determined among other things by the number of bidders: the greater the number of bidders the lower the bid price (see Glaister & Cox, 1991; White & Tough, 1995). For this reason, the target SQI needs to be achievable and not necessarily set equal to best practice. In the incremental approach proposed, the value of *z* can be predetermined through negotiation between the regulator and industry although the size of *z* should not violate the conditions for an incentive compliant tendering process. As part of the process of establishing the value of *z*, one might look to existing evidence on the differences between best practice SQI and a specific operator's SQI. That is, best practice might be used as a mechanism for partitioning the targets over the life of the contract. Fig. 14.3 illustrates such a difference between an operator (number 1) and best practice operator (number 2).[145]

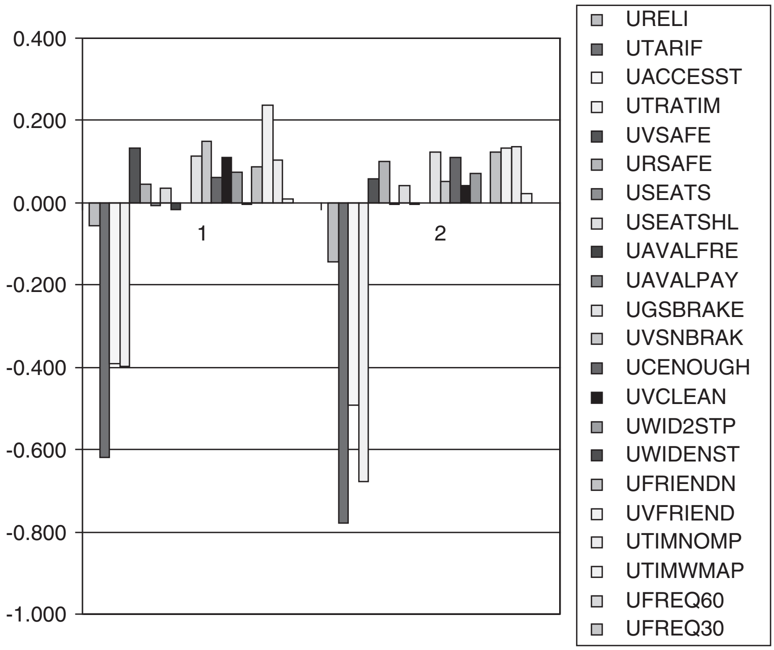


Fig. 14.3. A Comparison of an Operator against Best Practice.

Authorities can define the targeted service quality to be based on all or a subset of the attributes reported herein. One can, however, remove attributes that the regulator and/or the bus and coach industry might argue are not inclusions in an operational service quality indicator or that they should be held responsible for (e.g., in NSW all bus shelters are provided by local Councils).[146] For example, if it was argued that travel time and fares should be excluded this can easily be achieved with a new ordering of operators. SQI is therefore not only appealing for its simplicity (only one number) but also for its flexibility in accommodating changes in external factors (like changes in government policy or in the socioeconomic structure of the service area).

Moreover bus operators can be classified on a number of criteria agreed on between government and industry to arrive at operator membership of a segment. Benchmarking can then be undertaken within each segment (e.g., metropolitan/non-metropolitan area).

14.7.3. Monitoring and Responses

To ensure contract compliance the supplier must be monitored during the contract period. This involves collecting and interpreting information that can be used to determine whether the specified bus services are achieving the new-targeted SQI. Assuming a contract length of 5 years (as an example) we propose a performance assessment at the midpoint. An operator would conduct a user survey after 2.5 years to establish compliance.[147] To avoid any disputes on who should pay for the survey, it makes good sense to include the monitoring cost as part of transactions costs of the bid and included in the bid price. Table 14.7 summarises four possible outcomes of a contractual process.

If the operator is compliant it becomes a political decision whether the contract will be renewed or retendered at the end of the contract period. In case of non-compliance after the first half of the contract period, the non-compliant operator should be warned about under performance without loosing a contract. If the operator is unable to achieve the target performance by the end of the contract period the contract should be retendered. In the case of a non-compliant operator, the tendering authority must

Table 14.7. Possible Outcomes of a Tender.

	Renewal	Retender
Compliant	End of the 5 years	End of the 5 years
Non-compliant	Retendered	Retender: (warning after 2.5 years)

determine if the reasons for non-compliance are internal to the contractor (i.e., under his control) or external (i.e., not under control of the operator). Only internal failure needs to be corrected through sanctions. In case of external factors influencing the operator's service quality the tendering authority should review the pre-agreed targets.

The extent of benefits from competitive tendering depend not only on the size of the targeted SQI (see previous section) but also on other factors influencing the amount of competition. The size of irrecoverable costs, the length of the contract and the perceived probability of success will be critical factors in determining how many bidders come forward. The provision of information on existing service quality levels of the incumbent is essential to the success of the broadened specifications of competitive tenders if potential bidders are to be forthcoming.

14.8. CONCLUSIONS

We have developed an approach to quantifying a SQI to enable the economic regulator and bus operators to benchmark service effectiveness, adding this much-neglected dimension of performance assessment. The inclusion of service quality standards (i.e., SQI) in contract design avoids evaluation criteria exclusively based on a supply principle (cost efficiency). Competing offers can be judged according to their cost efficiency and service effectiveness. Indeed, we have convincing evidence from ITS's international benchmarking programme for the bus and coach industry that best practice operators on overall cost efficiency are seldom close to best practice on service quality.

We have established a global measure of service effectiveness to parallel the global indicators used to measure cost efficiency and cost effectiveness (i.e., total factor productivity). Although specific attributes may be included or excluded in particular settings and countries (and associated weights would change), the measurement approach should remain. Further details of the methods are presented in Prioni and Hensher (2000).

In a recent paper Muren (2000) has concluded that

> The incentive contract, with quality made explicit in the contract, resembles the net cost contract in that it is risky to the operator. The usefulness of incentive contracts depends on the possibility of devising service quality measurements that reflect operators' investment in quality reasonably well. If such performance-oriented quality measurements can be developed for public transport and, more generally, for competitevely tendered public services, there would be advantages in the short run through less expensive incentive contracts and less frequent tendering rounds, and in the long run in giving operators the incentive to develop better services (pp. 110–111). SQI $+ z$ may well be the measure.

CHAPTER 15

DEVELOPING A SERVICE QUALITY INDEX (SQI) IN THE PROVISION OF COMMERCIAL BUS CONTRACTS

15.1. BACKGROUND

There is an extensive literature (Fielding et al., 1985) on measuring the cost efficiency and cost effectiveness of bus services and operations. A major data input is the level of service output, typically measured on the demand side by annual passenger trips or passenger kilometres and on the supply side by vehicle kilometres. As aggregate indicators of total output, these measures implicitly assume homogeneity of service quality. Passengers, however, evaluate services in many ways that may not be systematically associated with the amount of use of the service; indeed it is unclear whether aggregate passenger kilometres can be a proxy for differences in passenger satisfaction across bus segments.

Several studies have since refocused on the measurement of service quality, investigating the role of trade-off methods such as SP (e.g., Prioni & Hensher, 2000; Hensher, 1991; Swanson et al., 1997) and univariate procedures that rate individual service items on a satisfaction scale (Cunningham et al., 1997). Although a passenger may perceive specific aspects of service quality as either positive or negative, we assume that the overall level of passenger satisfaction is best measured by how an individual evaluates the total package of services offered. Appropriate weights attached to each service dimension will reveal the strength of positive and negative sources of overall satisfaction. The SP paradigm enables us to develop preference formulae for a large number of service level scenarios, which can be implemented at the bus business level to establish operator-specific indicators of service delivery quality and effectiveness. The resulting satisfaction (utility) indicators obtained from the SP experiments measure the expected utility that a passenger obtains from the current levels of service and how this might change under alternative service level regimes.[148]

In 1999, the Institute of Transport Studies (ITS) began researching ways the bus and coach industry in New South Wales (Australia) might capture customer satisfaction with service levels (Prioni & Hensher, 2000, 2002). The intention was to provide insights into how quality could be built into a possible future government performance assessment regime, including calculating value for money in commercial bus contracts. It would also provide insights into the effectiveness of service levels from a passenger viewpoint and identify which service aspects are working best and which need more improvement. ITS undertook a pilot programme in which an on-board customer survey was undertaken with the support of 25 operators, focusing on a current trip and seeking information on passenger perceptions of service levels on 13 predetermined attributes. Stated choice (SC) methods were used, in which a sample of passengers were asked to choose their most preferred package from a number of alternative packages of service levels based on these attributes. MNL models were estimated to establish the relative weights attached to the statistically significant attributes, representing the contribution of each service attribute to the calculation of an overall Service Quality Index (SQI). The pilot programme showed the value of SQI as a way to capture customer perceptions of service quality.

In 2000, we embarked on the development phase. Two key features were identified that needed more attention: selection of service segments within an operator's domain, and a carefully structured sampling plan. This chapter presents the findings of this development phase. One major public operator and a major private operator were invited to participate and asked to propose service segments. A total of nine service segments were surveyed in this current round, sufficient to establish a benchmarking capability for ongoing monitoring for each segment and, through aggregation, for each operator.

We begin with an overview of the data requirements for quantifying SQI, including the selection of the attributes and the role of SC methods. The sampling plan is then presented. The logistics of data collection are described followed by a summary of the sample responses and a profile of the data on passenger perceptions of current service levels. Next, we describe the statistical models that establish the weights associated with each attribute in each service segment for each operator. Because we wish to benchmark each operator's market segment against the other segments, we introduce some specific details of how the statistical analysis is undertaken. In brief, because the relative importance of an attribute in a segment is scaled for comparability within the segment, to be able to undertake comparisons between segments we have to rescale the weights. The SQI measures are then calculated for each market segment with a comparison between each segment in terms of the overall SQI and its constituent attributes. The chapter concludes with a summary of major findings.

15.2. DATA REQUIREMENTS AND ATTRIBUTE SELECTION FOR SERVICE QUALITY MEASUREMENT

15.2.1. The Stated Preference Approach

The task is to develop an SQI that can be incorporated into a performance assessment regime that measures service effectiveness meaningfully from a passenger perspective. Such an index should be able to be decomposed into its constituent sources of passenger satisfaction. It should also map into an aggregate demand-side indicator of passenger output to establish the role of the latter as a practical approximation of the social-welfare significance of bus service levels.

With a complex disaggregation of service quality, data reflecting the experience from an existing trip alone, referred to as revealed preference (RP) data, are usually inappropriate. There is potentially too much confounding in RP data. Furthermore, some attributes of interest (e.g., air conditioning, low floor entry) may not exist today on many urban buses, so their influence cannot be determined.

SP methods provide the data richness required for quantifying an SQI, involving an SC experiment in which we systematically vary combinations of levels of each attribute to reveal new opportunities relative to existing service levels (Hensher, 1994; Hensher, Louviere, & Swait, 1999; Louviere et al., 2000). The attributes must be anchored to current experience, so that respondents can understand and relate to the attribute levels in a realistic way (Stopher, 1998). It is then important to create the other possible levels as reasonable variations on either side of the current experience. Failure to do this leads to respondents providing poor quality and inappropriate responses, as they try to relate to attribute levels that are totally outside their experience and sometimes difficult to imagine (Louviere et al., 2000). Through the experimental design approach, we survey a sample of travellers making choices between the current and other trip attribute level bundles. This approach is capable of separating out the independent contributions of each service component, and hence is capable of providing an SQI that is a rich representation of the statistically significant sources of service (dis)utility.

15.2.2. Defining the Empirical Setting and the SP Experiment

To help select attributes for SQI, we undertook an extensive literature review and a survey of bus operators with a wealth of experience on what customers look for in a good service (Prioni & Hensher, 2000, Chapter 13). We also benefited from the earlier pilot study (Hensher & Prioni, 2002). Together with extensive discussions during the development stage with key bus operators in Sydney, we concluded that 13 attributes describe the major dimensions of service quality from a user's perspective.[149] The range of levels selected for each attribute are shown in Table 15.1.

The attribute ranges were selected in consultation with the operators as representative of achievable variability. The attributes treated as continuous for the SP alternatives were relative to the current trip levels (e.g., travel time). The classificatory attributes (e.g., temperature on bus) included the level selected as the reference level for the current trip (from the levels offered in Table 15.1). The current level refers to the level associated with the trip in progress when the onboard survey was implemented. These data were obtained from passengers prior to completing the SP experiment).

Through a formal statistical design, the attribute levels are combined into bus packages before being translated into a survey form. The full-factorial design consists of 3^{13} combinations of the three levels of the 13 attributes. To produce a practicable and understandable design for respondents, we restricted the number of combinations to 81 choice sets using a fractional design that permits reduction of the number of bus packages, without losing important statistical information (Louviere et al., 2000). A pretest showed that respondents were able to evaluate consistently three choice sets resulting in 27 different survey forms. To allow for a rich variation in the combinations of attribute levels to be evaluated as service packages in the SP experiment, each bus operator received eight sets of 27 different survey forms (i.e., 216 forms) and instructions on how to organise the survey.

15.2.3. Sampling Strategy

The overall sampling plan was to distribute approximately 500 surveys on each of three segments (route types) from each of three depots, totalling 4,500 surveys. In addition, each of peak and off-peak runs were to be surveyed in each segment. The sample design was a multi-stage sample where the first stage was a stratified sample of routes within segments, the second stage a stratified sample of bus runs within sampled routes for each of peak and

Table 15.1. Attributes and Attribute Levels in the SP Experiment.

	Attribute	Level 1	Level 2	Level 3
1	Bus travel time	25% less	Same	25% more
2	Bus fare	20% less	Same	20% more
3	Ticket type	Cash fare	Pre-purchased bus-only 10-trip ticket or weekly	Integrated (bus and other mode)
4	Buses per hour at this bus stop (i.e., frequency)	50% more service	Same as now	50% less service
5	Time of arrival at bus stop	On time	5 min late	10 min late
6	Time walking to bus stop	Same	An extra 5 min	An extra 10 min
7	Seat availability on bus	Seated all the way	Stand part of the way	Stand all of the way
8	Information at bus stop	Timetable and map	Timetable, no map	No timetable, no map
9	Access to bus	Wide entry, no steps	Wide entry, two steps	Narrow entry, two steps
10	Bus stop facilities	Seats only	Seats under cover	No seat or shelter
11	Temperature on bus	Too hot	Just right	Too cold
12	Driver attitude	Very friendly	Friendly enough	Generally unfriendly
13	General cleanliness on board	Very clean	Clean enough	Not clean enough

off-peak, and the third stage a census of riders on selected runs. The third stage census makes it easier to administer in the field, because the surveyors do not have to perform any type of selection process, and cannot introduce a bias into the procedure. It also reduces the addition of further sampling error at this stage. In this paper, the geographical service segments are assigned the identifiers S1–S9. Some segments were CBD-based services, while others were local and cross regional services serving rail stations and local centres.

Peak travel was sampled more heavily than off-peak, with 2,700 surveys in the peak (7 am–9 am) and 1,800 in the off-peak (10 am–2 pm). Within each depot, the surveys were assigned equally to each segment. Thus, each segment was to have 500 surveys distributed, with 300 in the peak and 200 in the off-peak, rounded upwards to allow complete runs to be sampled. Each route in these segments was sampled approximately equally, as far as average ridership per run allowed. For three segments, there were only two or three routes in each segment. In the six other segments, there were too many routes to allow even one run per route to be included in the sample, so a simple random sample of routes and runs were chosen from each segment, until the desired expected ridership was reached.

15.2.4. Logistical Issues in Data Collection

The coordinator for each operator was briefed the week before the survey began and provided with the survey forms (sorted by bus segment) and the sampling rules. We sorted and allocated the 27 sets of survey forms, to ensure an equal distribution within each segment. The survey was undertaken in the last week of November and first week of December in 2000. One operator used their own senior staff to distribute and collect the forms and the other operator hired a survey firm for this task.

Although specific bus runs were provided by the sampling plan, the most important compliance condition was that the appropriate number of forms were distributed within each route and within each segment for each of the two time periods (7–9 am and 10 am–2 pm). For certain segments, operators were concerned about crowding conditions hampering the distribution of the forms. Shortage of interviewers on these segments combined with a higher number of bus runs meant that the required number of surveys could always not be circulated. In addition, there were often few customers on off-peak services as well as more elderly passengers for which there was a high rate of refusal. For other segments crowding was not a concern and so the full number of survey forms could be distributed using a similar number of interviewers as on the more crowded segments. For the off-peak components of service segments S2 and S3 the actual number of forms distributed exceeded the planned distribution, though this did not offset the shortfall in peak distributions. Overall, sufficient forms were returned to undertake the segment-specific analysis and determination of SQI.

15.3. SAMPLE RESPONSE

Table 15.2 presents response rates in several ways for each operator, segment and time of day. First is the planned distribution, followed by the number returned. The survey instrument comprised two double-sided A4 pages.[150] The first side had 25 questions about the current trip and the respondent. The attribute data sought were identical to that offered in the SP packages except for the service levels offered. Each of the remaining three sides set out one choice set for the SP experiment. The returns are grouped into four categories: front page details (RP) incomplete, RP completed only, RP plus one experiment only completed, RP plus two experiments completed, and entire form completed. Surveys that have the RP and at least one SP experiment completed are useful in statistical analysis: usable surveys are the sum of the latter three categories.

The actual number handed out is not known. This was partly due to the method used to administer the survey. When respondents returned blank forms, interviewers handed the same form to the next passenger. Logistical issues such as these will need to be re-assessed for future surveys. The number handed out was also not always the same as designed, because there were runs on which there were fewer passengers than expected.

These response rates are considered good for an on-board bus survey, where response rates are often as low as 15–25%. Only three segments showed a response rate against the planned distribution below 25%. In addition, completion rates of the surveys are considered good for on-board surveys indicating that the instrument is working well and that response to the survey has been positive. However, although interviewers were instructed not to give surveys to schoolchildren, they did so, which inflated the numbers somewhat, while providing surveys that must be excluded.

Table 15.3 provides a profile of the socioeconomic composition of sampled passengers. For each categorical person characteristic we provide the distribution of category membership; for each continuous variable we provide the mean, standard deviation and range. In Table 15.3, the totals are the number of respondents, excluding schoolchildren, who completed one or

Table 15.2. Response Rates by Segment.

Segment	Time of Day	Planned Distance	Status of Survey Form Completion					Total Responses	Total Usable Responses (% of Total Responses)	Usable Responses as % of Planned Distance
			RP incomplete	RP only	RP + SP1	RP + SP1 + SP2	RP + SP1 + SP2 + SP3			
S1	Peak	343	21	31	10	15	86	163	111 (68)	32
	Off-peak	200	1	50	12	9	84	156	105 (67)	53
S2	Peak	241	2	27	4	11	60	104	75 (72)	31
	Off-peak	158	26	51	9	12	90	188	111 (59)	70
S3	Peak	328	69	23	5	11	59	167	75 (45)	23
	Off-peak	216	59	69	17	13	74	232	104 (45)	48
S4	Peak	310	10	39	12	13	68	142	93 (65)	30
	Off-peak	203	9	47	8	6	64	134	78 (58)	38
S5	Peak	322	13	45	16	19	98	191	133 (70)	41
	Off-peak	210	8	72	12	14	86	192	112 (58)	53
S6	Peak	302	13	51	15	11	49	139	75 (54)	25
	Off-peak	193	8	52	16	16	35	127	67 (53)	35
S7	Peak	337	0	20	6	16	95	137	117 (85)	35
	Off-peak	224	1	45	9	8	38	101	55 (54)	25
S8	Peak	303	2	6	3	5	43	59	51 (86)	17
	Off-peak	220	4	42	15	8	46	115	69 (60)	31
S9	Peak	297	2	12	5	4	28	51	37 (73)	12
	Off-peak	214	2	17	1	9		29	10 (34)	5

Table 15.3. Socioeconomic Data by Segment.

Variable (%)	Segment									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	All
Gender										
Female	56.0	62.4	60.3	66.1	57.1	54.2	52.9	65.0	46.8	58.6
Male	40.7	34.4	36.3	33.3	40.8	36.6	45.9	33.3	51.1	38.5
Missing *N*	3.2	3.2	3.4	0.6	2.0	9.2	1.2	1.7	2.1	2.9
Total (*N*)	216	186	179	171	245	142	172	120	47	1478
Main occupation (%)										
Employed full time	38.4	40.9	41.3	56.7	43.3	37.3	68.6	46.7	51.1	46.5
Student	18.5	23.7	17.9	24.0	27.8	14.1	11.6	18.3	23.4	20.2
Looking for work	11.6	5.9	7.3	4.1	2.4	2.1	1.7	3.3	4.3	5.0
Retired or pensioner	11.1	5.9	13.4	3.5	13.9	38.7	10.5	19.2	6.4	13.4
Home duties	10.6	12.4	13.4	3.5	3.3	2.8	1.7	7.5	4.3	6.9
Other	9.3	9.7	5.6	6.4	9.0	4.2	4.7	5.0	8.5	7.1
Missing *N*	0.5	1.6	1.1	1.8	0.4	0.7	1.2		2.1	0.9
Total (*N*)	216	186	179	171	245	142	172	120	47	1479
Age (years)										
Mean	33.5	31.7	36.2	34.4	35.7	43.7	37.7	39.6	35.3	36.1
Standard deviation	14.6	13.5	16.0	13.4	16.1	19.6	15.3	16.8	14.7	15.9
Missing *N*	1	2		2	3	1	2		1	12
Total (*N*)	216	186	179	171	245	142	172	120	47	1497
Income (dollars)										
Mean	28,590.4	31,664.9	28,935.8	37,918.5	30,573.6	28,652.2	48,436.0	32,406.9	36,584.8	33,294.8
Standard deviation	16,688.5	22,147.3	17,014.7	20,518.9	19,980.2	18,149.8	24,316.4	19,190.7	22,198.3	20,845.2
Missing *N*		2		2	3	2	2		1	13
Total (*N*)	216	186	179	171	245	142	172	120	47	1,479

more SP experiments. Age and income were transformed from categorical data to continuous data (for modelling purposes). Lowest (18 and under) and highest age categories (65 and over) were recoded into 18 and 70, respectively. The lowest (under $12,000) and highest (over $80,000) income categories were recoded into $12,000 and $100,000, respectively.

The attributes associated with the SP design are summarised in Tables 15.4 and 15.5, but only for the levels associated with the current trip (RP levels). These are useful, because they are the basis of the input data used to calculate the SQI. A very high proportion of the sample had a seat all the way, suggesting either that there were few standing passengers or that standing passengers found it difficult to complete the surveys. This will need to be checked in future surveys, because it may be a potential source of bias. The other attributes have a good spread of responses in at least two of the three levels. On-board temperature is ‘just right’ for about 71% of passengers; the balance see it as too hot (and rarely too cold). Buses tend to be either very clean or clean enough and drivers tend to be very friendly or friendly enough.

On-time running (i.e., unreliability) shows buses arriving up to 25 min early or late with an average in the 0.2–3 min range. The majority of buses, however, arrived between three minutes early and three minutes late. This is one attribute on which the regulator places a great deal of importance (because it is relatively easy to measure external from the passenger); as shown later, it is also a statistically significant influence for the passenger.

Each passenger was given a choice set of three alternatives to evaluate (the current and two SP designed packages selected from the 81 available sets. They evaluated them and chose one. This was repeated a total of three times. Packages A and B are unlabelled (or generic) alternatives defined by the bundle of attribute levels and as such each package has no branding. Overall, however, 50.6% of passengers from one operator chose their current bus package (choice C), with 46% of passengers from the other operator choosing their current bus package.

15.4. STATISTICAL ANALYSIS TO QUANTIFY SERVICE QUALITY

15.4.1. SQI and Importance Weights

The derivation of SQI requires statistical estimation of models that reveal the importance weights attached to each attribute by the sample of passengers in each segment. The perceptions of passengers relative to the levels of each

Table 15.4. Revealed Preference Data by Segment (Categorical Variables).

Attribute (%)	Segment									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	All
Seat availability on bus										
Seat all the way	95.8	97.3	96.6	92.4	91.4	99.3	94.8	95.0	100.0	95.3
Stand for part of the way	3.2	2.7	2.8	5.8	8.6	0.7	3.5	5.0		4.1
Stand all the way	0.9		0.6	1.8			1.7			0.6
Total (*N*)	216	186	179	171	245	142	172	120	47	1,478
Bus stop facilities										
Seats only	6.9	10.2	15.6	36.8	31.4	45.8	32.6	24.2	8.5	24.1
Seats under cover	52.8	30.1	49.7	48.5	54.3	37.3	58.1	62.5	74.5	49.9
No seats or shelter	40.3	59.7	34.6	14.6	14.3	16.9	9.3	13.3	17.0	26.0
Total (*N*)	216	186	179	171	245	142	172	120	47	1,478
Information at bus stop										
Timetable and map	9.7	4.8	5.0	25.1	27.3	18.3	18.6	6.7	8.5	14.8
Timetable but no map	32.9	30.6	30.7	49.7	48.6	40.1	45.3	18.3	27.7	37.7
No timetable and no map	57.4	64.5	64.2	25.1	24.1	41.5	36.0	75.0	63.8	47.5
Total (*N*)	216	186	179	171	245	142	172	120	47	1,478
Access to the bus										
Wide entry, no steps	8.8	8.1	24.6	19.9	37.6	4.2	45.9	49.2	29.8	24.5
Wide entry, two steps	74.5	78.0	57.0	70.2	55.1	77.5	44.2	41.7	61.7	62.8
Narrow entry, four steps	13.4	7.5	12.8	4.7	4.1	14.1	5.8	5.8	6.4	8.4
Other	3.2	6.5	5.6	5.3	3.3	4.2	4.1	3.3	2.1	4.3
Total (*N*)	216	186	179	171	245	142	172	120	47	1,478
Temperature on bus										
Just right	60.6	68.8	72.6	77.8	87.3	45.1	64.0	76.7	89.4	70.6
Too hot	38.9	31.2	26.3	19.3	6.1	52.8	32.6	22.5	10.6	27.1
Too cold	0.5		1.1	2.9	6.5	2.1	3.5	0.8		2.3
Total (*N*)	216	186	179	171	245	142	172	120	47	1,478
Cleanliness of bus										
Very clean	24.1	32.3	27.9	24.0	29.4	26.1	33.7	34.2	36.2	29.0
Clean enough	70.4	65.6	69.8	70.8	65.3	69.7	57.0	59.2	53.2	65.8
Not clean enough	5.6	2.2	2.2	5.3	5.3	4.2	9.3	6.7	10.6	5.2
Total (*N*)	216	186	179	171	245	142	172	120	47	1,478
Friendliness of driver										
Very friendly	36.6	42.5	40.8	15.2	30.6	34.5	18.0	24.2	34.0	30.9
Friendly enough	59.7	54.3	55.3	78.9	62.4	61.3	77.9	72.5	66.0	64.7
Very unfriendly	3.7	3.2	3.9	5.8	6.9	4.2	4.1	3.3		4.4
Total (*N*)	216	186	179	171	245	142	172	120	47	1,478

Table 15.5. Revealed Preference Data by Segment (Continuous Variables).

Attribute (%)	Segment									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	All
Time to get to bus stop (min)										
Minimum	0.2	0.5	0.5	0.2	1.0	0.5	1.0	0.5	1.0	0.2
Maximum	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	25.0	30.0
Mean	5.5	5.0	5.2	5.4	8.3	7.2	7.4	7.5	6.0	6.4
Standard deviation	5.4	4.9	5.6	5.1	6.2	5.9	5.4	6.2	5.8	5.7
N	216	186	179	171	245	142	172	120	47	1,478
On time unreliability of bus (min)[a]										
Minimum	−12.0	−0.18	−0.24	−20.0	−25.0	−23.0	−20.0	−16.0	−23.0	−25.0
Maximum	17.0	10	19	20.0	19.0	20.0	20.0	20.0	15.0	20.0
Mean	1.9	0.76	1.2	3.51	1.1	1.2	0.8	0.2	0.4	1.4
Standard deviation	4.3	4.3	4.7	5.34	4.9	4.9	4.8	4.3	6.8	4.9
N	216	186	179	171	245	142	172	120	47	1,478
Number of buses in one hour interval										
Minimum	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Maximum	12.0	12.0	5.0	12.0	12.0	12.0	12.0	10.0	9.0	12.0
Mean	3.6	2.7	2.0	4.9	4.8	3.6	5.2	2.3	2.8	3.7
Standard deviation	1.7	1.4	0.7	2.4	2.7	2.0	2.5	1.2	1.6	2.3
N	216	186	179	171	245	142	172	120	47	1,478
Travel time on bus (min)										
Minimum	5.0	5.0	5.0	6.0	5.0	5.0	7.0	5.0	4.0	4.0
Maximum	60.0	45.0	30.0	60.0	60.0	60.0	60.0	60.0	30.0	60.0
Mean	17.3	17.9	13.8	30.3	24.8	19.7	32.2	22.7	17.1	22.1
Standard deviation	9.1	9.0	4.8	13.1	13.9	10.8	10.1	11.4	7.5	12.2
N	216	186	179	171	245	142	172	120	47	1,478
Cost of current one-way fare (dollars)										
Minimum	0.10	0.07	0.32	0.52	0.52	0.52	0.60	0.52	0.39	0.07
Maximum	5.85	6.34	6.50	5.00	7.20	7.20	9.00	9.00	3.75	9.00
Mean	1.97	1.95	1.77	1.96	2.03	1.66	2.26	1.90	1.69	1.94
Standard deviation	0.84	0.89	0.98	0.91	1.36	1.17	1.24	1.11	0.79	1.08
N	216	186	179	171	245	142	172	120	47	1,478

[a]Number of minutes that the bus was late. Negative values refer to the bus running early.

attribute as experienced in a current trip, and the levels offered in each SP package, together with the choice of the preferred trip package provide the necessary information to identify the importance weights. When the weights are identified, we have to multiply each attribute level associated with the current trip by the relevant weight and sum these calculations across all attributes to produce the SQI for each sampled passenger. An average across all sampled passengers using a specific segment provides the segment SQI, which measures overall perceived satisfaction with existing service levels. Each segment will have an overall SQI as well as information on the contribution of each attribute to that SQI. The latter is very useful in helping the operator gain an understanding of what are the main positive and negative influences on the overall level of passenger satisfaction with current services.

15.4.2. Benchmarking and Discrete Choice Modelling

The multinomial logit (MNL) model identifies the importance weights (Louviere et al., 2000). This simple method to obtain the importance weights has one limitation when the interest is in benchmarking SQI across geographical service segments. The desire to have separate models for each segment is linked to establishing unique importance weights for each attribute within each segment. We could naively pool the data across all segments and treat the importance weights for each attribute as the same (Prioni & Hensher, 2000). In principle this is quite acceptable if there are no statistically significant differences in the levels of the importance weights across the segment samples of passengers. However, it must be demonstrated rather than assumed.

For benchmarking we need to ensure that the SQI measures are comparable between segments. A discrete choice model is structured so that the information on the importance of each attribute is relative within a model. For example, if the importance weight for unreliability in segment[151] 1 is −0.4 and for bus fare it is −0.04, then we can compare these two weights and conclude that the unreliability weight per unit of unreliability is 10 times more valuable than the bus fare weight per unit of fare. If, in segment 2, the unreliability weight from a separately estimated model is –0.2, we cannot conclude that unreliability per unit is valued at twice the rate in segment 1 as in segment 2, because each separately estimated model has a different scale structure for comparing the importance weights.

Specifically, the MNL model derives importance weights with two components – scale and taste. Scale is derived from the underlying assumptions of the error structure. The MNL model assumes that this scale is the same across the alternatives being evaluated (i.e., current trip levels and the two SP packages) and can be set to 1.0. While this assumption can hold within a segment, we cannot assume that it holds across segments. If we assumed this, then we could pool the data for each segment and treat the scale as 1.0

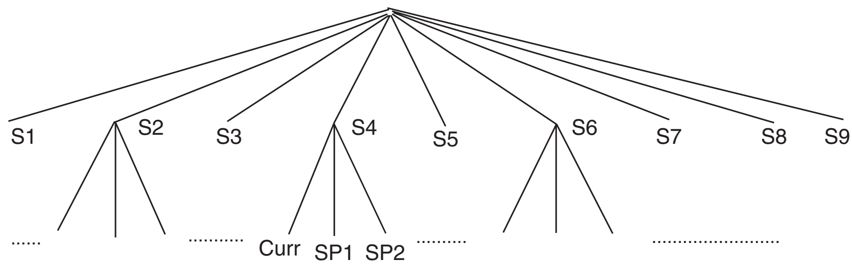


Fig. 15.1. Nesting Structures Used in Model Estimation to Permit Comparisons of SQI between Nine Segments.

for all alternatives associated with all segments. Because we have no way of knowing it is true before we test the assumption, we have to redefine the structure of the model to be estimated so it can reveal the extent of differences in scale (if they exist) when we pool the data. We must pool the data because we want to undertake benchmarking and must ensure that the importance weights (and hence segment SQIs) are directly comparable.

To account for potential scale differences, each segment is treated as having three alternatives (current plus two SP packages), which are different because of scale differences. We then have 27 alternatives. The structure is shown in Fig. 15.1 where each respondent provides information to one branch in the tree structure and each branch is a segment (S1, …, S9), revealing the scale differences empirically. Previous research (Hensher & Bradley, 1993) shows how the scale parameter can be identified using this procedure. Essentially we use the nested logit structure as a 'trick' to reveal differences in scale since we are pooling data across nine separate samples drawn from the nine geographical segments. We normalise the scale value for one segment (by setting it to 1.0 – segment 4) and allow it to be free for the other eight segments.

15.4.3. SQI Model

The final nested-model system is summarised in Table 15.6. The dependent variable is binary, where the chosen package is given the value of 1.0 and the other two non-chosen packages are given the value of zero. The model then establishes the statistically most efficient weights to explain the choices made. The focus of the survey is on the attributes themselves, without reference to any particular label describing any package. Each package is a combination of attributes and associated levels and is referred to as an unlabelled

Table 15.6. The Final Model Used to Identify the Importance Weights and Scale Differences between Segments for Scheduled Route Services (School Children on Passes Have Been Excluded).

Attribute	Segment Importance and Scale Weights (*t*-value in Parentheses)[a]								
	S1	S2	S3	S4	S5	S6	S7	S8	S9
Travel time (min)	−0.0333 (−3.8)	−0.0346 (−3.2)	−0.0249 (−1.5)	−0.0440 (−4.9)	−0.0396 (−3.9)	−0.0356 (−3.2)	−0.0280 (−3.3)	−0.0272 (−2.7)	−0.0362 (−2.1)
One-way bus fare ($)	−0.6519 (−4.5)	−0.7136 (−4.4)	−0.7508 (−4.0)	−0.5592 (−4.3)	−0.6394 (−4.6)	−0.5948 (−4.4)	−0.6256 (−4.2)	−0.5543 (−2.9)	−0.5543 (−2.9)
Unreliability (min)	−0.0317 (−1.8)	−0.0322 (−1.4)	−0.0626 (−1.7)	−0.0399 (−2.6)	−0.0649 (−3.3)	−0.0119 (0.5)	−0.0116 (−0.8)	−0.1127 (−3.9)	−0.1029 (−1.9)
Access time to bus stop (min)	−0.0248 (−2.0)	−0.0725 (−3.9)	−0.0859 (−3.4)	−0.0081 (−.8)	−0.0449 (−3.4)	−0.0696 (−3.4)	−0.0128 (−1.1)	−0.0567 (−3.6)	−0.0768 (−2.7)
Bus frequency (/h)	0.0923 (3.0)	0.0840 (2.0)	0.2729 (2.8)	0.0490 (2.0)	0.0858 (2.6)	0.1187 (2.2)	0.0869 (2.8)	0.1440 (2.9)	0.0523 (0.6)
Seat all way (1,0)	0.6529 (3.8)	0.6661 (3.0)	0.5159 (2.5)	0.4380 (3.1)	0.4622 (2.8)	0.5310 (2.1)	0.7734 (4.7)	0.3560 (1.9)	0.9531 (2.0)
Stand part way (1,0)				0.2367 (2.5)	0.2367 (2.5)	0.2367 (2.5)	0.2367 (2.5)	0.2367 (2.5)	0.2367 (2.5)
No. timetable, No. map (1,0)	−0.1850 (−1.4)	−0.4216 (−2.3)		−0.1372 (−1.1)		−0.2464 (−1.5)	−0.2913 (−1.9)	−0.2033 (−1.2)	−0.1210 (−0.5)
Narrow four steps (1,0)	−0.4455 (−2.7)	−0.1535 (−0.8)					−0.5709 (−3.1)		
Wide entry two steps (1,0)	−0.5124 (−3.2)	−0.4899 (−2.7)					−0.5748 (−3.3)		
Seat only at stop (1,0)	0.6102 (4.2)	0.6102 (4.2)	0.6102 (4.2)	0.1851 (2.5)	0.1851 (2.5)	0.1851 (2.5)	0.1851 (2.5)	0.1851 (2.5)	0.1851 (2.5)
Seat under cover at the bus stop (1,0)	0.6102 (4.2)	0.6102 (4.2)	0.6102 (4.2)	0.1851 (2.5)	0.1851 (2.5)	0.1851 (2.5)	0.1851 (2.5)	0.1851 (2.5)	0.1851 (2.5)
Very clean bus (1,0)		0.3228 (2.9)			0.3228 (2.9)	0.2262 (1.7)		0.3228 (2.9)	
Very friendly driver (1,0)		0.1704 (1.4)	0.1704 (1.4)	0.2089 (1.7)	0.2263 (1.9)			0.2263 (1.9)	
VTTS ($/h)	3.06	2.92	1.99	4.72	3.72	3.59	2.68	2.94	3.92
No. of observations[b]	580	511	472	454	646	336	463	304	122
Scale value	0.9835 (4.6)	0.5019 (3.8)	0.6326 (4.4)	1.0000 (fixed)	0.7270 (4.7)	0.4212 (3.0)	1.065 (5.6)	1.0727 (4.4)	0.8370 (3.2)
Log-likelihood					−3848.9				
Pseudo R^2					0.69				

[a]Missing attribute weights mean that the attribute was too insignificant to report for the segment where it was highly non-significant.
[b]The minimum number of observations per respondent was 1 and the maximum was 3 (i.e., 3 or less SP experiments completed).

alternative. Hence, all the weights attached to a specific attribute (e.g., travel time) are the same across the three packages. These weights can vary between segments, but where they are not statistically significantly different, they are constrained to be the same in the final model. Eight scale parameters have been identified relative to the scale for segment 4, which is set equal to 1.0. The overall explanatory power of this highly non-linear model is very high (a pseudo-R^2 of 0.69).[152] For a linear model this is close to 0.9.

Some attributes are not statistically significant in all segments, and hence their contribution to SQI is not significant. The presence of strong support for a specific statement (e.g., ''this bus is very clean'') does not indicate that this is an important issue in the passenger's overall satisfaction with the service package being offered. This choice approach, in which one evaluates the current trip levels and two alternative service packages, enables one to assess the role of each attribute in influencing the choice between service packages. Six variables are significant for all segments, namely one-way bus fare, seat all the way, stand part way, wide entry two steps, seat only at stop, and seat under cover. In addition, travel time is significant on all but S3, bus frequency on all but S9, access time to bus stop on all but S4 and S7, narrow 4 steps on two of the three segments where it was presented, and very clean bus on three of the four segments where it was presented. Unreliability varied, sometimes being very significant (S4, S5, S8), and in other cases not significant. Very friendly driver was never significant, and no map, no timetable was significant only once.

Some attributes tend to be dominated by support on two levels, such as driver friendliness, bus cleanliness and getting a seat on the bus. For example, 95.6% of passenger responses described the driver as very friendly or friendly enough; and 94.8% of the passengers described the bus as either very clean or clean enough. Consequently the best specification of these attributes was achieved by setting the best level relative to the other levels. Hence, 'very clean' and 'very friendly' are the only attributes in the model for bus cleanliness and driver friendliness. The interpretation of the importance weights is straightforward. A positive weight indicates that a very clean bus adds to utility the equivalent of its importance weight compared to a bus that is not perceived as very clean (i.e., is predominantly clean enough with a few passenger perceiving it as not clean enough).

The scale parameters, varying from 1.065 to 0.4212, are all statistically significant although there are quite a few segments where the scale parameters are statistically similar. Thus, we cannot pool all the data for each segment and treat the scale as 1.0 for all alternatives associated with all segments, but we could pool subsets of service segments. The SQI utility index has to be multiplied by this scale parameter to enable benchmarking.[153] Where the SQI is positive, a scale value less than 1.0 reduces the SQI value; where the SQI is negative, a scale parameter less than 1.0 increases the SQI value and highlights the implications of ignoring the scaling on rank ordering of segments. There is substantial re-ordering except for S4.

The implied values of travel time savings (VTTS) are informative. They vary from $2 to $4.72 per person hour. Bus users generally have lower VTTS than car and train users, with the values herein varying between 14 and 34% of the gross average wage rate of the sample. However, there is one important caveat to note – unlike previous studies we have separated out the in-vehicle time from the unreliability of travel time, which tends to otherwise inflate the mean VTTS for in-vehicle time.

15.4.4. Benchmarking Service Quality

The parameter estimates combined with the perceptions of service levels on each attribute associated with the current trip provide all the data necessary to derive the SQI measure for each segment. The products of each parameter and the associated attribute level across the sampled passengers are summarised in Table 15.7. We calculated the actual utility contribution of each attribute for each passenger, summed them in each segment and took the average.[154] The overall SQIs are shown in Fig. 15.2 and the contributions of each attribute are shown in Fig. 15.3.

The absolute magnitude of each line in Fig. 15.3 represents the contribution of an attribute to the overall level of SQI. Each attribute in Fig. 15.3 is identified by a number for easy tracking. A large positive contribution (above the zero horizontal line) is clearly the preferred outcome, compared to a large negative contribution (below the zero axis). As might be expected, travel time (1) and fare (2) are the greatest sources of negative satisfaction. In comparison, service frequency (4) and getting a seat (6) are the greatest sources of positive satisfaction. Positive or negative satisfactions refer to the passenger's current perception of service level conditioned on the relative importance to the passenger of this service level attribute. Thus, the fare level is the greatest contributor to passenger dissatisfaction for all segments except S4 where travel time is a greater contributor (although fare level is still a major concern). It seems clear that reducing fares will be a major contributor to improving SQI, with travel times a close second. Operators might argue that they have limited room to move in adjusting fares and travel times, the former heavily influenced by the regulator and the latter

Table 15.7. SQI and its Contributing Components by Segment (All Scaled).

Variable	Segments								
	S1	S2	S3	S4	S5	S6	S7	S8	S9
Travel time	−0.573	−0.315	−0.218	−1.343	−0.719	−0.300	−0.965	−0.671	−0.534
One-way bus fare	−1.273	−0.709	−0.859	−1.103	−0.953	−0.394	−1.412	−1.294	−0.773
Unreliability	−0.077	−0.030	−0.079	−0.159	−0.092	−0.010	−0.023	−0.150	−0.215
Bus frequency	0.327	0.113	0.350	0.236	0.303	0.182	0.481	0.360	0.125
Access time to bus stop	−0.135	−0.176	−0.286	−0.045	−0.272	−0.212	−0.100	−0.469	−0.382
Seat all the way	0.617	0.327	0.317	0.404	0.310	0.222	0.776	0.363	0.798
Stand part way	0.000	0.000	0.000	0.015	0.014	0.001	0.010	0.013	0.000
No timetable no map	−0.105	−0.135	0.000	−0.034	0.000	−0.041	−0.112	−0.164	−0.066
Narrow four step entry	−0.074	−0.011	0.000	0.000	0.000	0.000	−0.059	0.000	0.000
Wide two step entry	−0.373	−0.193	0.000	0.000	0.000	0.000	−0.277	0.000	0.000
Seat under cover at the bus stop	0.354	0.127	0.254	0.159	0.116	0.066	0.180	0.170	0.132
Very friendly driver	0.000	0.036	0.044	0.031	0.049	0.000	0.000	0.053	0.000
Very clean bus	0.000	0.054	0.000	0.000	0.070	0.025	0.000	0.111	0.000
SQI	−1.313	−0.914	−0.476	−1.839	−1.174	−0.463	−1.501	−1.678	−0.915
SQIunsc	−1.335	−1.820	−0.753	−1.839	−1.614	−1.099	−1.409	−1.565	−1.094
Rank order Sc	6	3	2	9	5	1	7	8	4
Rank order unsc	4	8	1	9	7	3	5	6	2
SQI Normalised to base 1	1.526	1.925	2.363	1.000	1.665	2.376	1.338	1.161	1.924

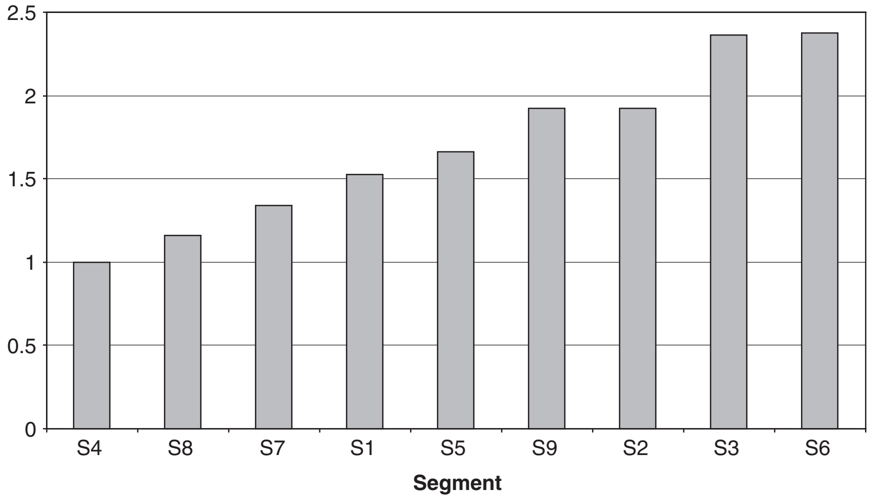
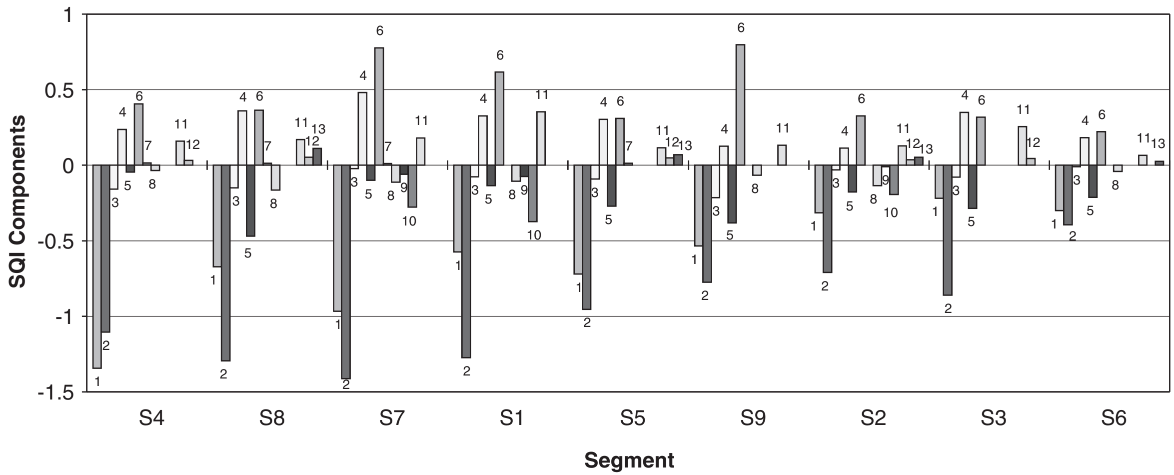


Fig. 15.2. SQI for Each Segment Normalised to 1.0.

influenced by external factors such as traffic congestion and the general quality of the road environment. Nevertheless it signals a number of issues that operators must address with the other agencies that influence their operating environment.

Looking at the attributes over which the operator has more direct control, having a seat all the way (6) is a source of substantial positive satisfaction, especially for S7, S9 and S1. Access time to bus stop (5) combined with service frequency (4) and service unreliability (3) may be the key drivers of service delivery. All three attributes are substantially under the operator's control and seem to be where the major focus for service improvements should be directed. The provision of infrastructure at the bus stop is a local government obligation in NSW. It appears that passengers in S1 are best served in respect to seat and shelter (11), with passengers in S6 the worst served. Bus cleanliness (13) and driver friendliness (12) have limited relevance to SQI across all segments. In future studies, one may reconsider the need for such attributes. One might speculate that these attributes become insignificant in contrast to the fundamental attributes of time, fare, unreliability, comfort (i.e., getting a seat) and service frequency.

The access conditions of the bus (i.e., steps and width) have a significant negative influence for some segments (i.e., S1, S2, S7) with 'wide entry with 2 steps' relative to 'wide entry with no steps' having the greatest negative



1. Travel Time	6. Seat all the way	11. Seat under cover
2. One way bus fare	7. Stand part way	12. Very friendly driver
3. Unreliability	8. No timetable no map	13. Very clean bus
4. Bus frequency	9. Narrow 4 step entry	
5. Access time	10. Wide to step entry	

Fig. 15.3. Decomposition of SQI into its Components for Each Segment.

Table 15.8. Ranking of the 13 Attributes in the SQI.

Attribute	Segment								
	S1	S2	S3	S4	S5	S6	S7	S8	S9
Positive attributes									
Seat all the way	1	1	2	1	1	1	1	1	1
Bus Frequency	3	3	1	2	2	2	2	2	3
Seat under cover at the bus stop	2	2	3	3	3	3	3	3	2
Very clean bus	–	4	–	–	4	4	–	4	–
Very friendly driver	–	5	4	4	5	–	–	5	–
Stand part way	–	–	–	5	6	5	4	6	–
Negative attributes									
Narrow four-step entry	4	6	–	–	–	–	6	–	–
Unreliability	5	7	5	8	7	6	5	7	5
No timetable No map at bus stop	6	8	–	6	–	7	8	8	4
Wide two-step entry	8	10	–	–	–	–	9	–	–
Access Time to bus stop	7	9	7	7	8	8	7	9	6
Travel time	9	11	6	10	9	9	10	10	7
One-way bus fare	10	12	8	9	10	10	11	11	8

impact. There is clearly room for improvement here, with the potential to increase satisfaction being sufficient to impact the overall SQI rank order of the segments. This sort of diagnosis should be undertaken by each operator to reveal opportunities for service improvement.

Table 15.8 shows the rankings of the attributes for each segment, arranged so that those contributing positively are listed first, and those contributing negatively are listed last. Those with the lowest rankings have the strongest positive effect on the SQI, while those with the highest rankings have the strongest negative effect on the SQI. As an example, consider segment S5: 'having a seat all the way' and 'bus frequency' are the two strongest positive contributors; 'standing part way' is the smallest positive contributor, and 'unreliability' the smallest negative contributor; 'travel time' and 'one-way bus fare' are the two largest negative contributors. 'Wide2-step entry' is a greater source of negative satisfaction than 'narrow 4-step entry'. This is clearly an issue for clarification in further studies.

15.4.5. Determining SQI at the Depot Level and in the Future

The SQI could be determined for a depot, rather than a geographical service segment, although this would lose the variability between segments, which is shown above to be quite large. This would be accomplished by estimating an average, weighted by the number of passengers in the segments. More correctly, the models could be re-estimated for each depot using pooled data for the depot instead of for the segments. Similarly, if the desire were to compare segments with each according to depot, this would also require re-estimating the models without the inclusion of any data from another operator (i.e., the segments of one depot in the first case, and those of the other in the second case in this experiment).

If one operator decides to re-survey the same segments at some point in the future and wishes to know if there are changes in the SQI, it would be advisable first to re-estimate the weights for the SQI based on that operator's segments alone, and then apply the new survey attribute levels with the new weights obtained in re-estimation. It would also be possible to apply the new survey attribute levels to the existing weights, but the results are more clearly correct if re-estimated weights are used.

15.5. CONCLUSIONS

This chapter has progressed the development of SQI at a more detailed level within an organisation than the previous pilot study. In addition, we have developed and implemented a more rigorous way of identifying the importance weights to attach to statistically significant attributes that recognises the differences in scale between the utility expressions associated with each segment. This is crucial if one is to compare the performance of each segment (i.e., benchmark) meaningfully.

The findings serve a number of purposes. From an operator perspective, they reveal what matters to actual customers and provide some signals as to which attributes need more effort in being marketed to potential patrons. Some of the identified influences on passenger satisfaction are not directly under the control of the bus operator and offer the challenge to influence others (e.g., local government) to contribute to making bus services more attractive. However, recognition of this within the framework of the broader set of influences on passenger satisfaction is very important.

CHAPTER 16

NON-COMMERCIAL CONTRACT REIMBURSEMENT: THE INSTITUTE OF TRANSPORT STUDIES (ITS) MODEL

16.1. INTRODUCTION

The Institute of Transport Studies (ITS), under its quality partnership with the Bus and Coach Association (BCA) of New South Wales (NSW), was commissioned to examine and review the current payment base for non-commercial bus contracts in NSW. The current payment base (in 2002) was devised by Price Waterhouse Coopers (PwC) and has been in place since 1991, with revisions, in 2000, to accommodate the implementation of the goods and services tax (GST). The BCA requested ITS to review this payment base under the Quality Partnership between BCA (NSW) and ITS (Syd). The request arose out of concerns presented by the Independent Pricing and Regulatory Tribunal of NSW (IPART) in a report dated June 2002. IPART promoted the need to critically examine and consider alternatives to the following components of the payment base: asset depreciation, risk premium, and the representativeness of the components of bus-related costs in a post-GST economy. The BCA asked ITS to recommend a defensible level of risk, real rate of interest and residual value for the BCA's submission to IPART for the 2003–2004 determination. The BCA specifically requested that we examine a payment base in which funds are received for the dollars of the year in which services are provided, providing an alternative to the current situation of paying in the previous year's dollars. The BCA also requested advice on the financial impact, if any, of the varying road surfaces (in particular, bitumen vs. gravel roads) on which rural operations occur.

To ensure that the data on cost and performance were current, the BCA undertook a survey of non-commercial bus operators in the last quarter of 2002, seeking details of operations for the year starting 1 July

2001. The BCA supplied ITS with a total of 231 completed surveys: 21 category one, 72 category two, 58 category three and 80 category four. This represents approximately 13% of all non-commercial bus contracts in NSW. It was assumed that this constituted a representative sample.

In addition to the non-commercial operator survey, the BCA carried out a survey of commercial operators. For both commercial and non-commercial contract categories, the BCA invited ITS to determine and quantify a series of key performance indicators (KPIs) that would appropriately summarise the performance of each operator and each contract class.[155]

The chapter is structured as follows: Section 16.2 examines the survey data and details assumptions that were made. Section 16.3 examines the ITS model as a replacement for the PwC model. The ITS model is a mixture of specific improvements to the PwC model together with features of the PwC model that are valuable inclusions. Differences between the PwC and ITS approach are documented. Section 16.3 is further divided into an examination of the replacement value of the vehicle, bus-related costs, distance-related costs, the effect of gravel roads on business running costs, an examination of defensible inputs for the 2003 determination in 2003 dollars and a comparison of the PwC and ITS model summary sheets. Section 16.4 recommends methods and factors with which to update the 2003 determination into 2004 dollars.

16.2. QUALITY OF SURVEY DATA

The data received from operators were in varying states. Owing to misunderstandings on what was being asked of operators, some ambiguities presented themselves in the data. As such, cleaning of the data was necessary. The survey data for the estimated capital value of a vehicle compares closely to the figures provided by an industry source, a private second-hand vehicle dealer (Table 16.1). The comparability provided one source of evidence for a high level of confidence in the survey data. Although the capital costs reported by the respondents for 12–15-year-old vehicles were dissimilar to industry data, this was due to the small number of respondents. Overall, the similarity of the two sets of data portrays the strength of the survey data.

16.2.1. Cleaning the Data

The standard editing and follow up on specific data items were undertaken prior to analysis. A series of assumptions were made (and documented

Table 16.1. Capital Costs of Category Four Vehicles in 2002, Survey and Industry Data.

Capital Cost – Category Four		
Age of vehicle	2002 Survey data	2002 Industry data
0	$223,833	$195,000
1	$183,333	$175,000
2	$183,571	$150,000
3	$148,056	$145,000
4	$145,000	$140,000
5	$136,667	$130,000
6	$106,200	$125,000
7	$103,000	$120,000
8	$95,833	$105,000
9	$83,571	$95,000
10	$88,333	$90,000
11	$87,500	$80,000
12	$61,667	$75,000
13	$95,000	$65,000
14	$0	$55,000
15	$25,000	$50,000

Note: 2002 industry data supplied by Colin Coy of Mercedes with revisions made by Frank D'Apuzzo of BCA.

below) as we progressed through the editing task, resulting in what we deem to be a 'clean' data set. Some or all of the factors that necessitated these assumptions were the result of an ambiguous survey instrument. A copy of the survey form including notes for improvements in the future is provided in Appendix 16A. The main assumptions imposed in the data editing process are given below:

1. Contract and actual hours were assumed to be in hours and minutes and therefore altered to a decimal number to aid data manipulation.
2. Although the survey asked for fuel prices without allowing for the diesel and alternative fuels grant scheme (DAFGS) rebate, where low prices were given (relative to our experience on prices), we assumed that a respondent had allowed for the DAFGS in the reported fuel cost. A rule was used as follows: if the respondent reported a diesel price per litre of less than or equal to 85 cents, DAFGS was assumed taken into account.

3. A number of respondents included very high depot improvement costs (at G2 'other') and administration costs at 'other plant/equipment' (E37). These costs were assumed to be purchase costs. If unadjusted, these costs would skew the overall costs of the respondents' operation. It is unreasonable to assume that these costs be written off in one year. Therefore, the annualised cost of capital (ACC), discussed later in the report, was used. The ACC assumed an economic life of 20 years and, in the absence of other information, used a residual rate of zero.
4. As intended by the BCA, costs reported under 'other contract costs' (G1) and 'other administration costs' (E33) were either deleted or relocated. The most frequent entries into 'other contract costs' were wages and workers compensation. The likelihood of this occurring was high because wage-related costs were not requested elsewhere within the survey instrument. Most costs reported under 'other administration costs' were in error and relocated to the appropriate heading.
5. The reported income received through charter was deemed unreliable. These data were of no consequence to non-commercial contract cost determination (although we note that it often provides the financial support that has enabled survival of many operators). It has been excluded from the KPIs for non-commercial contracts.
6. Wage costs were calculated by assuming that the employee was being paid for the specific task undertaken. Driving hours were paid as casual and subject to the dual capacity allowance. Administration hours were paid as casual at grade five. Mechanic hours were paid as casual. All wage rates used were current award conditions as of July 2002.
7. Loan repayments that were incorrectly included under bank charges (E3) were moved to the item 'annual capital repayment cost' (F2).
8. Operators that reported administration, and repairs and maintenance costs that were grossly dissimilar to other operators, which would have resulted in total costs dwarfing total revenue, were deemed unreliable and excluded.
9. Operators with low contract kilometres and therefore very high costs per kilometre, even if there was a reason for this, were excluded on the basis of skewing the results across all operators.
10. Where an operator reported no expenditure on rent or rates, an average for all reported rates across the sample in the contract class was entered.
11. The costs reported in the survey were assumed to include GST unless stated otherwise. The GST component was removed.

12. Owing to ambiguities in the survey, respondents could enter the cost amount for lube/oil under two different categories. Where the respondent did not report an oil/lube amount it was assumed that this was included under repairs and maintenance. The component of lube/oil for operators that reported lube/oil and repairs and maintenance separately was taken and applied to other operators such that a separate figure was generated for lube/oil cost to be used in the ITS model.
13. Where the age of the vehicle was not provided, the year of acquisition and age at purchase was used.

16.3. THE ITS MODEL

The ITS model and the PwC model exhibit a number of differences. The major differences coincide with the concerns raised by IPART in their June 2002 report (IPART, 2002). These concerns dominate the BCA's mandate for this report. Each component of the model is presented in turn.

16.3.1. Asset Replacement Value

A weakness of the PwC model's approach to depreciation is the reliance on weighted average capital costs through time. This approach appears to be a response to insufficient capital cost information. PwC did not have recent survey data from a sample of operators. Given such data together with access to industry knowledge of specific items (e.g., market value of vehicles by type and vintage), we are able to improve on this very aggregated assumption. ITS promotes an alternative method to account for depreciation, using a method called the ACC. ACC takes into account depreciation, the (real) rate of interest and the economic life of the vehicle rather than the 'useful life' utilised by PwC. A real rate of interest is used as a measure of the opportunity cost of capital and assumes that if capital is borrowed that it is repaid at the same real rate of interest plus inflation. If money is not borrowed it is assumed that it could be invested elsewhere at the stipulated real rate of interest.

We use the market value of a vehicle as the minimum-risk estimate of what an asset is worth (regardless of vintage) even though the market for used vehicles is not in any sense perfect (in a fully competitive sense). Simply put, we want to ensure that the amount of money paid to an operator includes a sum that reflects the cost of replacing a bus at the same level of quality when the time arrives to replace it (i.e., no diminution in asset quality). This need not be at the end of its economic life, in which case the residual sale value would be higher. The value of the asset does not include the costs of financing a loan. The cost of servicing the loan (relative to the opportunity cost of capital in ACC) is an additional risk of the business and must, therefore be included in the risk premium. Essentially, this is the difference between the real rate of interest used in the ACC formula (a minimum-risk rate) and the loan or investment rate secured.

It is important to shift the focus from the accountant's straight definition of depreciation and consider the replacement cost of the vehicle. The strength of the approach to the depreciation of the vehicle must be measured by the ability of the operator to replace the vehicle at the end of its economic life.

16.3.2. Calculating the ACC

The following two equations outline the method of calculating the ACC for a specific vehicle during a specific year. Defensible values for the inputs are included later.

$$\text{ACC} = (\text{MV} - \text{RV}) * \text{AF}$$

where ACC is the annualised cost of capital ($/annum in constant dollars), MV the market of the vehicle in constant dollars, RV the residual value of the vehicle (= to the MV*residual rate), and AF is the amortisation factor or cost recovery factor (below).

$$\text{AF} = \frac{r}{1 - \left(1/(1+r)^{(e-a)}\right)}$$

where r is the real interest rate (e.g., 0.06), e the economic life of vehicle, and a is the age of vehicle.

The interest rate used depends on the status of the capital. If the vehicle was bought outright a real rate of interest is used based on the gilt-edged 10-year bond rate plus the additional return on investment that operators claim they get by investing capital in more risky portfolios. If the vehicle is leased or hire purchased an interest rate including the cost of servicing the debt is used (which is the 10-year bond rate plus an increment if appropriate). Utilising vehicle capital costs provided by industry organisations and vehicle suppliers for a typical vehicle type in each contract class, the ACC was calculated for each age for a given year, e.g., for the non-commercial category four contract in 2002. ACCs were derived for each vintage, from new vehicles through to the maximum economic life of the vehicle, the sixteenth year of life. From the results of the survey we know the age of the fleet. The ACC for each age of vehicle was weighted by the vintage shares in the sampled contracts to provide a contract class weighted average annual cost of capital.

$$\text{TOTAL\_ACC} = (\text{ACC}_0 * W_0) + (\text{ACC}_1 * W_1) + (\text{ACC}_2 * W_2) + \cdots + (\text{ACC}_e * W_e)$$

where ACC is the annualised capital cost for a given aged vehicle and W is the proportion of total vehicles of that age in the fleet (%).

Full details of the calculation inputs into ACC are provided in Appendix 16B. Appendix 16B shows the ACC worksheet for a category two contract from the ITS model for the 2002 reimbursement year. The worksheet shown represents the components of ACC from the ITS model. However, due to space constraints, the look and feel of the worksheet in Appendix 16B differs to that used in the implementation model. Each year it will be necessary to input the key variables: namely the real rate of interest, the economic life of the vehicle, the residual value of the asset, and the market value of the vehicle for each vintage.

16.3.3. Discussion

IPART in its report 'weighted average cost of capital (WACC) – discussion paper', August 2002, discusses the WACC concept and why it is the preferred measure of annualised capital cost. The ITS formulation presented in the previous section is similar in intent to WACC but is much simpler to calculate as well as being appropriate to the nature of the business in the bus sector. WACC is of primary benefit to stock exchange listed companies in fields that are readily comparable, e.g., public utilities. WACC assumes that a company will have a spread of investments across stocks and bonds. This is not the case of private bus operators. The majority of bus operators are small operators, where the main form of investment is the capital purchase of the vehicle itself.

Importantly the ACC is calculated for 16 *different* buses in the case of an economic life of 16 years. That is a new bus in the given year, a one-year-old bus in the given year, etc., up to a 15-year-old bus in the given year. Therefore, we are dealing with a different bus for each age (essentially vintage), and as such ACC does not lend itself to linear analysis as would be the situation with a single vehicle being amortised through time. The ACC represents the capital cost of the vehicle 'consumed' by working the asset for each year of the rest of the economic life of that vehicle. The ACC is very responsive to the asset's economic life, its residual rate and the opportunity cost of capital.

The ACC assumes that the vehicle is either bought outright at the minimum-risk real rate of interest or financed at the same rate. In practice, most operators borrow at a rate above the minimum-risk rate. The addition of a separate 'full cost of servicing debt' factor in addition to the ACC would not be appropriate, as it would produce double counting (or 'double dipping'). The operator would be paid for the opportunity cost of capital they did not possess (given the asset is 'owned' by the finance agency) as well as reimbursement for the debt that they entered into. The most appropriate method of including the cost of servicing the debt is by defining it as the sum of the opportunity cost of capital based on the 10-year bond rate (and included in the ACC) plus a differential to account for the additional cost of servicing the loan by a more riskier source of finance than the10-year bond rate. In addition, it seems appropriate that we recognise the additional opportunity cost when the operator's own finances are used to acquire the bus instead of investing such capital in other portfolios that are likely to yield a return above the minimum-risk real rate of interest.

16.3.4. Bus-Related Costs

Bus-related costs include those related to the administration of the bus operation, the maintenance and running of the depot and the running of the contract route. This includes costs such as accountancy fees, bus registration, utilities, rates, rents, greenslip, bank fees and so on. Examination of the basket of costs included under 'bus-related costs' was two-fold. We undertook a review of the applicability of the existing method used to factor bus-related costs from one year to the next, and, a determination as to whether the costs currently being used in the model were representative of a typical bus operation. If this was not the case, we recommended new cost values and categories.

16.3.5. Factoring of Costs from Year to Year

The method employed in the PwC model to update the basket of bus-related costs from one year to the next requires all costs to be indexed by an ANTS impact-adjusted CPI rate. This was imposed no matter the extent to which CPI impacted upon the cost. PwC argued that CPI affected all the costs to varying degrees and that overall the increase reflected the CPI rate. IPART has expressed reservations about this approach. When constructing the methods used to factor the costs within the ITS model, we focussed on an approach that would make the model as transparent as possible. It was important not to make the implementation of the ITS model difficult and ambiguous to use, for whatever reason such as demand on the amount of input data required. This review separates those costs which can be easily updated and are independent of regular CPI-related increases.

The PwC model used data contained in ITS reports from 1996 (King, 1996a, 1996b). The data from these reports were factored to 2000 dollars by the implementation of yearly CPI rates. The first CPI rate applied to the data was for the period March 1996–1997. However, the data included in the 1996 ITS reports were collected in October and November 1995. The PwC model did not account for the inflation on costs between December 1995 and March 1996 – a task that would have been easily achieved.

The new model uses award rates of pay to factor increases in the administration and cleaning wage rates. This entails updating the wage sheet at the introduction of new award wage rates. This arrangement was already the case for driver wages included under 'driver-related costs'. The bus-related costs sheet will maintain the same look for this category.

16.3.6. Changes to Categories and Costs

A deficiency of the PwC model is the double counting of some cost items. Items included at 'other costs' and individually were 'signs and advertising' and 'bus cleaning'. The double counting of 'signs and advertising' contributed an extra \$101 on average to each operator in 2002. The ITS model, where possible, contains only data gained from the survey. Therefore, the likelihood of double counting appears minimal as opposed to the PwC approach, which utilised two overlapping data sources. Table 16.2 presents a comparison of the percent representation of components of bus-related costs, excluding administration and cleaning wage costs (examined later), in the PwC model and the BCA survey results. The survey data are unweighted averages across all respondents; when a 'no answer' was assumed to be a zero value (after extensive checking for validity of such responses).

A number of cost item categories used by PwC do not adequately present the costs faced by bus operators. When the survey costs are re-categorised into those used in the PwC model, 'other costs' shows an increase of 516.86%. The survey did not provide costs for 'hire replacement bus', 'off street parking' or 'timetable/pass' and only part costs for 'depot cleaning'. The PwC model did not include depot costs such as occupational health and safety compliance costs, environmental protection act compliance costs and

Table 16.2. Comparison of the Survey and PwC Model 'Bus-Related' Component Costs in 2002 for a Category Four Contract.

PwC Model Categories for 'Bus-Related Costs'	Survey		PwC 2002		% Change Survey vs. PwC
	$	% of total[a]	$	% of total	
Accountancy	807	5.87	848	8.13	−4.82
Bank fees, charges	468	3.40	969	9.29	−51.77
Bus registration	795	6.61	1,888	18.09	−51.84
Cleaning materials	219	1.59	261	2.50	−16.13
Depot cleaning	48[b]	0.35	485[c]	4.65	−90.11
Electricity	253	1.84	222	2.12	14.23
Greenslip	1,168	12.00	1,037	9.94	59.21
Hire replacement bus	[d]	0.00	349	3.34	−100.00
Insurance	562	19.31	1,151	11.03	130.88
Maintenance facility	1,286	9.35	993[c]	9.51	29.47
Off street parking	[d]	0.00	332	3.19	−100.00
Other costs	3,212	23.88	532[c]	5.10	516.86
Rates, rents	1,498	10.21	709	6.79	98.25
Signs and advertising	134	0.98	101	0.97	32.50
Telephone	636	4.62	465	4.45	36.79
Timetable/pass	[d]	0.00	93	0.89	−100.00
PwC cat.s Total	11,086	100.00	10,436	100.00	
Depot costs[e]	6,547				
Total	17,633				

[a]Per cent of survey total cost excluding depot costs, as not included in the PwC model.
[b]Only part costs included in survey.
[c]PwC model uses a parts and labour division, combined here.
[d]Not included in survey.
[e]Depot costs were not included in the PwC model.

local government costs. The survey indicates that bank charges and bus registration costs have declined significantly. 'Insurance' and 'greenslip' costs have significantly increased.

The concerns expressed by IPART over the representativeness of bus-related costs post-GST implementation seems founded. The survey results indicate that the PwC basket of costs did not represent those incurred by the operator in fulfilling the contract. It was necessary to construct a transparent 'bus-related' cost structure. The PwC model included 'bus insurance comprehensive' costs on a per kilometre basis. This approach was inappropriate, as this is a fixed cost. Accordingly, 'bus insurance comprehensive' cost was moved from 'distance-related costs' to 'bus-related costs' as a fixed cost. Table 16.3 shows this structure and details the components of each category.

Table 16.3. Revised Structure of Bus-Related Costs With Components in 2002.

ITS Model Cost Categories	Contract Category Type (Costs ($))				Components
	One	Two	Three	Four	
Associated staff costs	293	329	560	517	Conferences and seminars, OH&S systems, staff recruitment, training, uniforms
BCA membership	255	253	251	246	BCA membership
Bus insurance comprehensive[a]	580	692	1,028	1,400	Bus insurance comprehensive
Bus registration	528	599	665	795	Registration
Communications	434	535	560	666	Telephone/fax, internet, couriers and freight
Depot cleaning costs	259	482	462	485	Cleaning materials, plus shortfall of PwC amount[b]
Depot costs	904	1,377	4,876	6,547	Depot costs security, waste/EPA
Financial management costs	1,032	1,181	1,512	1,440	Accountant, bank charges, legal fees
Greenslip	1,019	1,102	1,150	1,168	Greenslip
Hire replacement bus	346	346	346	349	PwC amount[b]
HVIS costs	102	120	167	142	HVIS costs
Maintenance facility	856	1,203	1,055	1,286	Repairs and maintenance, surveillance systems, communications equipment, computer hardware, other plant/equipment
Off street parking	330	330	330	332	PwC amount[b]
Office supplies	305	353	393	556	Amenities, computer consumables, computer software, postage, printing, stationery
Other	586	133	191	212	Donations, journal subscriptions, other, sponsorships, towing
Other insurance	321	579	549	562	Other insurances (e.g., public liability)
Property costs	1,608	942	1,176	1,529	Rates, rent, land tax
Signs	31	36	53	134	Signage
Survey vehicle	539	720	912	1,251	Motor vehicle running costs to survey route
Utilities	216	234	239	23	Electricity, gas
Total	10,542	11,546	16,475	19,871	

[a]Included in PwC model as a distance cost.
[b]No value available from 2002 survey, value used from the PwC model which was 1995 survey data from a 1996 report then factored for inflation.

The costs included at 'other' in Table 16.3 were identified as a range of items each below $100, for category four contracts. Many cost items had no unique or obvious classification and indeed they are a disparate set of items. Donations and Sponsorships, included at 'other', represent a real cost for operators, with an average reported cost of $91. Operators, particularly in small communities, argued this as a legitimate cost to their business, as it was expected of them to contribute to the school that they serviced through the contract. The fuel costs associated with the running of a survey vehicle were included. Operators reported that road flooding necessitated the use of a survey vehicle to regularly assess the condition of the contract route and possible alternative routes. The expense associated with the production of timetables and bus passes has been assumed in some cases to be included in 'printing' and 'stationery' costs and in some cases included in 'office supplies'. Given the ambiguity in the survey it has not been entered separately. Water rates were not requested in the survey. If the operator is cleaning the bus on site they use water, it therefore follows that they pay for that water. It was not possible to factor this expense into the cost structure. Given many operators work out of their residential premises, we might reasonably argue that it is a shared cost fully allocated to the residential activity.

Concerns exist over the representativeness of the PwC estimates for 'hire replacement bus' used as in the ITS model given the absence of suitable survey data. The PwC amount was based on a survey with a high representation of metropolitan operators (provided by ITS in 1996). The majority of non-commercial contracts are in rural areas where you would expect a greater need for the hire of replacement buses, due to extreme road conditions. Therefore, due to the lack of country-based data the figure used in the ITS model may under-represent 'hire replacement bus' costs. Responses to the cost of land tax on the business seemed low but there was no way to rectify this without additional data.

In 2002, there were redundant columns in the PwC cost sheet, which were associated with the implementation of GST. These columns, e.g., 'expected flow-on effect' and 'Other ANTS impact', have now been deleted along with other minor inputs associated with previous policies (e.g., the rows used to factor in extra administration hours to account for GST implementation and DAFGS compliance). These 'add-on' rows are no longer necessary in the new model; survey information provides an up-to-date evaluation of the number of administration hours needed to facilitate the contract. Table 16.4 shows the change in form of the 'non-driver labour' cost component of 'bus-related costs'. Note that the separation of 'administration hours' and 'wage

Table 16.4. 'Non-driver Labour' Component of 'Bus-Related Costs': Data and Layout for a Category Four Contract, DAFGS Eligible, in 2002 Dollars.

Category Four Contract			
ITS model		PwC model[a]	
Cleaning hours	173.73	Cleaning hours	256.44
Wage rate ($)	17.06	Wage rate	19.50
Administration hours	146.68	Administration hours	103.20
		Additional admin hours	6.00
		Additional admin hours-DAFGS	33.00
Wage rate ($)	24.93	Wage rate	19.50
Non-driver labour total ($)	6,619.42	Non-driver labour total ($)	7,772.97

[a]The PwC model uses monthly data and then multiplies the total by 12 to give a yearly total, to ease comparison hourly data were multiplied by 12.

rate' in the ITS model is there to enable comparison with the PwC model categories. This separation does not exist in the working model.

The cleaning hours reported in the 2002 BCA survey were much lower than those reported by ITS in 1996, as used in the PwC model. The administration hours reported were 5.52 h less. The use of award wage rates in the ITS model is a preferred approach than indexing wage rates by CPI, as undertaken in the PwC model. Had the CPI-indexed wage rates been substituted into the ITS model, total non-driver labour would have cost $6,247.63, $371.79 less than when award wages were used. There could be an argument that the cleaning and administration hours reported in the 2002 BCA survey were conservative. The data used for this section of the PwC model were taken from a 1996 ITS report (King, 1996b) summarising the results of a daily diary survey undertaken by 506 operators. By asking the operator to only focus on information for the period of a month, a lower burden was placed on that operator, than that of asking for information for the whole of the preceding year. Scaling up from 12 months can be problematic.

The costs utilised in the ITS model are conservative. We would not be surprised to find that a more reliable (i.e., less ambiguous) survey would yield higher costs. All costs however, on balance, appear reasonable and defensible.

16.3.7. Distance-Related Costs

Distance-related costs include the cost of fuel, oil, repairs and maintenance expressed on a per kilometre basis. The PwC model includes cost per kilometre relationships from 1996 reports, later factored by CPI or, in the case of fuel the percent increase in fuel price. The survey enables the updating of the cost per kilometre relationships and an examination of the categories chosen.

16.3.8. Factoring of Costs from Year to Year

The PwC model uses CPI to factor the costs from one year to the next. This should not be the case for in-house mechanics wages, a component of repairs and maintenance costs. Using the average number of mechanic hours reported in the survey the new model utilises award wage rates. Changes to award wage rates will require data input. The most appropriate method to update repairs and maintenance costs and oil costs continues to be through CPI.

16.3.9. Changes to Categories and Costs

The PwC model expressed 'bus insurance comprehensive' costs as a distance-related cost. This cost is a fixed cost and has been included under 'bus-related costs' in the ITS model. The PwC model refers to in-house repairs and maintenance costs, which it splits into subcategories: parts and labour. However, the survey revealed that repairs and maintenance were carried out both within the operation and by external businesses. This is reflected in the ITS model. The ITS model includes the cost per kilometre estimates from the survey. The mechanic wage rate used is the award rate of pay. Table 16.5 shows the distance-related cost layout of the ITS model, using edited survey costs, compared to the PwC model.

The survey data incorporated into the ITS model reveals a decline in repairs and maintenance costs since 1995 in real terms. Oil costs per kilometre have also decreased. 'Distance-related costs' are lower for category four operators than category three operators. The kilometre relationships here utilise the contract kilometres fulfilled by the operator. Basing cost decisions on actual kilometres does not represent the true cost of servicing a contract. Any kilometres travelled additional to the contract kilometres in order to service the contract route are unpaid under the current contract regime and therefore not figured into the model. All relevant costs are accounted for in the ITS model.

The PwC model displays fuel costs independently of 'distance-related costs'. The ITS model maintains this division. Owing to the large cost of fuel, there was merit in maintaining a different heading for fuel on the summary sheet and therefore on the costs sheet. The ITS model utilises the

Table 16.5. Distance Related Costs in 2002, ITS Model (with Revised Layout) Using Survey Costs Compared to PwC model.

ITS Model	Contract Categories				PwC Model	Contract Categories ($/km)			
	1	2	3	4		1	2	3	4
Oil cost/km ($)	0.009	0.012	0.020	0.016	Oil	0.007	0.010	0.025	0.024
Repairs and maintenance					Repairs and maintenance				
– Inhouse labour	912	5,730	6,144	7,616	– Parts	0.077	0.086	0.138	0.177
– Hours									
– Wage ($/h)	19.99	19.99	19.99	19.99	– Labour	0.059	0.055	0.097	0.106
– Cost/km ($)	0.031	0.052	0.067	0.064					
– All parts and external labour cost/km ($)	0.088	0.113	0.153	0.155	Bus insurance (comp)	0.037	0.034	0.036	0.047
Total ($/km)	0.128	0.177	0.240	0.235	Total	0.180	0.186	0.296	0.354

Table 16.6. Comparison of Fuel Costs per km between the ITS and PwC Models by Contract Category and DAFGS Eligibility, in 2002 Dollars.

Model	Category One		Category Two		Category Three		Category Four	
	DAFGS		DAFGS		DAFGS		DAFGS	
	Eligibility	Ineligibility	Eligibility	Ineligibility	Eligibility	Ineligibility	Eligibility	Ineligibility
ITS	$0.1286	$0.1642	$0.1510	$0.1928	$0.1531	$0.1955	$0.1957	$0.2499
PwC	NA	$0.1221	$0.1028	$0.1336	$0.1496	$0.1944	$0.1703	$0.2213

survey data to calculate the fuel cost per kilometre for each category of contract. The primary reason for the use of this data source was the non-availability of rural diesel prices. Refer to the fuel section of 'Justifiable factors for 2003' for a cogent argument. Table 16.6 displays the fuel cost used in the ITS model compared to the PwC model, in 2002 dollars.

The ITS model has included a fuel cost for both diesel and alternative fuel grant scheme (DAFGS) eligible and ineligible contract category one operators. This division did not occur in the PwC model. The survey indicated that a majority of category one operators were eligible for DAFGS. It was therefore logical to include this division. If the PwC model approach was continued, category one operators would not be suitably reimbursed, some operators being paid too much and others too little.

16.3.10. Gravel Roads

The BCA requested that we consider whether the percent of gravel roads on the contract route impacted on the running costs of a bus operation. It seems reasonable that extra wear and tear on vehicles would be caused by prolonged travel over loose road surfaces. The survey did not request the information necessary to answer this question. The BCA undertook a phone poll of the category four contract operators who responded to the survey. Regression analysis failed to find a relationship between the percent of gravel kilometres on the contract route and either total cost per contract kilometre or repairs and maintenance costs per contract kilometre. ITS recommends further study into this relationship in conjunction with future industry surveys. Previous studies have indicated a relationship between road condition and tyre cost per kilometre, and between fuel consumption per kilometre and road condition (Hensher, 2003c). The strengths of these relationships were found to vary due to contract category. Attention must be paid to gathering percent gravel kilometres on the contract route for all contract categories.

16.3.11. Driver-Related Costs

Driver-related costs concern the wages paid to the driver of the bus. We undertook a review of the components used in the PwC model and confirmed their relevance or otherwise when compared to the relevant award. The applicable award was the Motor Bus Drivers and Conductors (State) Award.

The PwC model includes a per hour component and a per day component in line with the requirements of the award. This approach has been retained. One error was found in the PwC model. The Australian Tax Office Superannuation Guarantee ruling concerning ordinary time earnings (1994) stated that allowances were to be included in wages for the purposes of calculating superannuation. The PwC model does not reflect this. Every non-commercial contract holder has been under-reimbursed since 1994. This situation is rectified in the ITS model.

16.4. JUSTIFIABLE FACTORS FOR 2003

16.4.1. Risk

A simple but appropriate definition of risk associated with investing in a business is that it is the opportunity cost of capital for a given project. In other words that amount of money that would have been received had it been invested in a pursuit of similar risk. This has two components: the risk-free and the risk-premium parts. The risk-free component is the amount of return that would have been received on the money had it been invested in a 100% risk-free venture. This is widely accepted as being the current, or projected, 10-year gilt-edged government bond rate, discussed below. The risk premium is discussed here.

It is necessary to consider a portfolio that offers risk commensurate to the project. In addition, when looking at the rates of return for investments it is necessary to look at annual rates of return over long periods as common stocks fluctuate so much that averages over short periods are meaningless. Brearley, Myers, Partington, and Robinson (2000) report the average rates of return for government bonds and shares for Australia from 1882 to 1987.

The authors found that the 10-year government bond average return was 5.21% per year and the ordinary shares average annual rate of return was 13.06%. The risk premium reported by Brearley et al. (2000) is the difference between the average annual rates of return provided by ordinary shares minus the same for 10-year government bonds, which equals 7.85%. The authors highlight that investors are getting increasingly cautious and that a risk premium between 6 and 8% is reasonable.

A discussion paper produced by the IPART in August 2002 on the 'WACC' details the current level of risk premiums accepted across a range of government bodies for utilities. *All bodies accept a risk premium of six percent as reasonable.*

Central to the argument offered by Brearley et al. (2000), who provided an historical risk premium of 7.95%, was the use of common stocks as an appropriate measure of risk. Such an approach requires the scale of business to be quite large as it implies that the return would be tied to the stock market. The majority of the bus and coach industries are small operators, with none listed on the stock exchange. Therefore, there is an extra risk involved above that of a stock exchange listed company. This would lead to the assumption that given a market accepted risk premium for utilities of 6%, the bus and coach industry requires an extra component above this. The principal justification for this statement is the requirement of bus operators to maintain an average fleet age, assumed to be eight years for non-commercial contract categories one and two and 12 years for non-commercial contract categories three and four. This would be akin to requesting that all energy distribution infrastructures be replaced on an eight, or twelve, yearly basis. This requirement considerably increases the risk of running a bus and coach operation. The cost of purchasing new capital is considerably hindered by the nature of the second-hand vehicle market. Considering the average fleet requirements, used vehicle prices are very unpredictable and typically low.

Brearley et al. (2000) show that the average rate of return for small firm common stocks to be, over the period 1926–1994, 17.4%. This represents a risk premium over government bonds of 12.2%. The risk associated with the private bus and coach industry does not directly relate to the risk inherent in the general small firm, because of an assured reimbursement from the government. However, it does show that there is a greater risk inherent with smaller operations.

The ACC calculations assume that the vehicle is bought outright. Therefore, the opportunity cost of capital (i.e., the real rate of interest) used does not account for the risk associated with leasing or hire purchasing the vehicle. The majority of vehicles on non-commercial contract routes are either leased or hire purchased. The 2002 survey reveals that at least 69.9% of the vehicles are either leased or hire purchased. Our review of the survey data suggests that a higher percent of vehicles are likely to be leased or hire purchased than reported. The survey question was not totally clear on what was required. However, the additional risk associated with servicing the debt of the vehicle equates to the difference between the five-year fixed-term business loan or lease rate and the real rate of interest used in the ACC calculations. A review of business loan and lease rates, included at Appendix 16C, revealed an average rate of 7.45% per annum. The difference between this rate and the average 10-year government bond rate for the year from the 1st of April 2002 to the 31st of March 2003 of 5.65% was 1.81%, due to rounding.

Factors that impact on the risk of investing in a non-commercial bus contract include:

- very high capital costs under current average age laws;
- servicing that high level of capital debt;
- greater risk associated with small businesses when compared to stock-listed companies;
- uncertainty over the government's predilection to the removal of the five-year contract period;
- the government's preferred position of putting the contracts to competitive tendering;
- government action related to restructuring the number of contracts operated;
- growing competition from unstructured alternatives – car pooling, PVC and pseudo charter operations;
- declining student numbers in some bus contract areas increase the risk of the cessation of contracts, at no fault of the bus operator; and
- increasing costs associated with the running of a non-commercial contract through additional administrative requirements due to legislative changes, with no change in the reimbursement scheme to account for this.

The combination of the above points and in particular the very high capital costs in the bus and coach industry under current average age laws, the greater risk associated with smaller businesses and the risk associated with the cost of servicing the capital debt, argues for a market risk premium over the 6% afforded large stock market listed companies. It is difficult to justify a specific percent amount for any of the generators of risk above, except for the cost of servicing the capital debt, as there is no empirical evidence available establishing the risk of bus operations in Australia or abroad. Therefore the minimum reasonable risk premium associated with running a non-commercial bus contract in NSW is the addition of the risk afforded large stock market listed companies and the risk incurred through the necessity of leasing or hire purchasing the main capital asset. This equates to a risk premium of 7.81% for 2003. The components of this figure will be reviewed prior to any IPART submission.

The risk premium is applied to the capital cost of the asset. The capital cost of the vehicle, in this case, equals the sum of the capital costs of each age of vehicle weighted subject to their representation in the fleet. This is shown in the equation below:

$$\text{RISK\_PREMIUM}(\$) = \{(\text{CC}_0 * W_0) + (\text{CC}_1 * W_1) + (\text{CC}_2 * W_2) + \cdots + (\text{CC}_e * W_e)\} * R$$

where CC is the capital cost for a given aged vehicle ($), W the proportion of total vehicles of that age in the fleet (%), and R is the risk rate (%).

16.4.2. Real Rate of Interest

Accepted industry practice is to utilise the Reserve Bank's 10-year bond rate. Previously, PwC has used a figure obtained from a single day, in May or March, depending on when the report was due. However, the bond rate fluctuates daily. This approach seems to be arbitrary. To remove this bias the ITS model utilises the average 10-year bond rate over the previous year (i.e., from 1/4/02 to 31/3/03).

16.4.3. Loan Rate

The calculation of the risk premium utilises the prevailing loan rate. The loan rate used must accord with what a bus operator actually incurs. To this end, a five-year fixed-term, non-residentially secured loan rate was used. To recognise that operators also hire purchase their capital asset, the five-year lease rate is used. An average rate is taken from across a sample of representative financial institutions (see Appendix 16C).

16.4.4. CPI

The CPI rate is used to update previous year's costs to the current year. The calculation of the CPI rate has previously entailed taking the Reserve Bank of Australia (RBA), quarterly, all groups, CPI rate for Sydney and then applying an adjustment factor. The adjustment factor was generated by Econtech to account for ANTS implementation. The CPI rate for Sydney was used as it was the closest figure to NSW country available. If a quarterly CPI rate was not available at the time of submission a forecast was used. This method is thoroughly defensible and remains in the ITS model.

16.4.5. Fuel Price

The cost of fuel is measured on a per kilometre basis. To express fuel prices in current dollars, the method used in the PwC model was to take an average weekly diesel price obtained from Mobil and the percent change in the price per litre of diesel from the preceding year, the latter used to factor the in(de)crease in the fuel cost per kilometre. This is in line with the method used to calculate fuel price in the commercial model. IPART is in favour of this approach and it is retained in the ITS model. However, the fuel price obtained from Mobil was from the metropolitan Sydney area. The overwhelming majority of non-commercial contracts are rurally based. The last available data relating to the difference in the diesel price between Sydney and country NSW is circa July 2000 (ACCC, 2000). This study found country NSW diesel fuel to be 3.2% more expensive than Sydney diesel. More recent data are available only for petrol price differences (FuelTrac, 2003). The average increase in petrol prices in 34 country NSW locations compared to Sydney for November and December 2002 was 4.7%. These figures illustrate that the current method for ascertaining diesel prices, from Mobil Sydney data, is inadequate.

The ITS model uses the weighted average price of diesel reported in the 2002 BCA survey. The diesel price per litre was weighted by the contract category's representation in the total non-commercial contracts in NSW. This resulted in a diesel price of 94.0 cents/L. For the sake of an example, if it is assumed that there is a 4.7% difference in diesel price between Sydney and country NSW, a country diesel price per litre of 94.0 cents equates to a Sydney diesel price of 89.5 cents/L. This diesel price is similar to the Sydney diesel price provided by Mobil, which was used in the PwC model. The ITS model proposes the use of the CPI fuel component to further factor in(de)creases in the price of diesel, until such time that an adequate monitoring regime of country NSW diesel prices is undertaken. The fuel component of CPI is available quarterly from the Australian Bureau of Statistics. The 2003 fuel price used will therefore equal the weighted average fuel price found in the survey, factored by the fuel component of CPI. The survey covered the period until the end of June 2002; therefore the fuel component of CPI used was the increase that occurred from June 2002 to March 2003. This ensured no double counting.

It was a requirement of bus operators to use low sulfur diesel (LSD) from the 1st of January 2003. This requirement added an extra 1 cent/L to the price of diesel. It is difficult to ascertain whether this increase in price was accounted for by the fuel component of CPI. Given this ambiguity, it has been assumed that the increase in price has been accounted for.

16.4.6. Capital Cost

For the ACC formula to produce the most accurate replacement cost, current industry capital costs are used. These capital costs are based on the prevailing market environment and therefore better reflect capital cost changes than CPI.

16.4.7. Wage Rates

The wage rates used in the reimbursement model are subject to award conditions for the proceeding year, the same method that has been employed previously. From the 1st of July 2003 superannuation payments are included in wages for the purposes of calculating workers compensation (Workcover New South Wales, 2003).

16.4.8. Residual Rate of Buses

The residual rate of buses has been set according to industry expertise and advice. Industry believes that residual rates of 15% for contract categories one and two, and 5% for contract categories three and four are defensible. The capital costs utilised in the ACC calculations do not depreciate subject to the residual rates recommended by industry. This relates to the uncertainty of the market value through resale. The market for vehicles is split between those subject to average age laws and those that are not. The operators that are not subject to average age laws, e.g., tourism operations, maintain market values. These are the true market values for the typical vehicles of that contract type. However, the non-commercial contract operator is more likely to receive the residual rate reported here at the end of the economic life of the vehicle.

16.4.9. Economic Life

The average bus age requirements set down by the NSW government dictate that the average age over the five-year contract be eight years for contract category one and two buses and 12 years for contract category three and four buses. This means that the maximum age for a contract category one or two bus is 16 years and for a contract category three or four bus is 24 years. Owing to these constraints, the economic life of a contract category one or two bus is 10 years and for a contract category three and four bus is 16 years.

16.5. COMPARISON OF PWC AND ITS MODELS

This section compares the performance of the PwC model to the ITS model in 2002 and 2003 dollars, in separate sections. This comparison is for a category four contract operating for 100 km, 4 h a day for 201 days of the year, utilising a bus that is DAFGS eligible. The component cost sheets are as per the explanations of the ITS model previously in this report. This comparison explores the different cost and revenue totals generated by the models and compares the designs of the summary sheets. Copies of the ITS model and PwC model summary sheets are included in Appendix 16D for the 2002 reimbursement year, and Appendix 16E for the 2003 reimbursement year.

16.5.1. Look and Feel

The ITS model summary sheet is simpler to use than the PwC sheet. The PwC model summary sheet retained a number of rows that have since become redundant, e.g., j-no. of buses, k-average bus age (years), l-bus safety package, due to initiatives already adopted. For this reason, there was no need to include a section relating to the non-compliance of the average age of the vehicle. The PwC model summary sheet also included additional information unrelated to the functioning of the sheet, e.g., g-depreciation rate and I-residual value of bus. There was no need to alter the categories pertaining to distance, bus-related and driver wage costs. The PwC model summary sheets, except contract category one, do not make reference to the application year. The ITS model presents the application year at the top of each contract category's summary sheet.

The major changes in the look and feel of the summary sheet relate to the changes in the concepts used in the ITS model. The ITS model utilises ACC.

This approach negates the need for the return on investment rate and working categories, the depreciation rate and working categories. The ITS model summary sheet uses the new categories of ACC and risk premium, and combines the spare bus and spares allowance. According to current practice, both the ACC and risk premium amounts are included under the 'required return' heading, and not under 'costs'. The ITS model summary sheet, at the top, includes the four fields requiring inputs from the operator: kilometres per day, hours per day, number of contract days, and DAFGS eligibility. The grouping of fields requiring manual input was not a feature of the PwC model summary sheet.

16.5.2. Calculations – Category Four in 2002 Dollars

The inputs used are common to both the ITS and PwC models and were those utilised in the 2002 reimbursement submission. The PwC model is as per the 2002 submission. The ITS model utilises costs from the 2002 BCA survey with appropriate amendments. The ITS model reimburses the category four non-commercial operator in the 2002 example by the sum of $97,122. The PwC model reimbursed the operator by $84,119. The ITS model better reflects the replacement cost of the vehicle and uses up-to-date cost information. Refer to Appendix 16D for a detailed overview of the value of the different inputs.

An overview of the total revenue required per bus for the ITS model and the PwC model is provided in tabular form in Appendix 16F. The two models are compared for contracts of six different distances, between 50 and 300 km, and 10 different lengths, between 1.5 and 10 h. Fig. 16.1 compares the required revenue for a four hour per day non-commercial contract across six distances for the ITS and PwC models during the 2002 reimbursement year.

The ITS model produces higher levels of required return for contracts operating four hours per day across all distances.

16.5.3. Calculations – Category Four in 2003 Dollars

Both the ITS and PwC models were factored to 2003 dollars. The latest available input factors were used. The methods outlined in the 'Justifiable factors for 2003' section were used in the ITS model. The methods used previously in the PwC model were again employed. The factors used here are up-to-date and ready for submission to IPART. The ITS model reimburses the category four non-commercial operator in 2003 with $98,527. The PwC

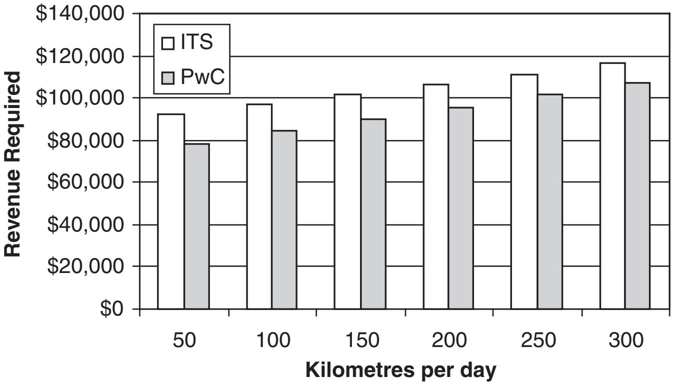


Fig. 16.1. Required Revenue for a Category Four Contract Operating for Four Hours per Day, across Six Distances, the ITS Model Compared to the PwC Model, 2002 Dollars.

model reimburses the operator with $86,398. The ITS model better reflects the replacement cost of the vehicle and uses up-to-date cost information. Refer to Appendix 16E for a detailed overview of the value of the inputs.

An overview of the total revenue required per bus for the ITS model and the PwC model is provided in tabular form in Appendix 16G. The two models are compared for contracts of six different distances, between 50 and 300 km, and 10 different lengths, between 1.5 and 10 h. Fig. 16.2 compares the required revenue for a four hour per day non-commercial contract across six distances for the ITS and PwC models for the 2003 reimbursement year.

The ITS model produces higher rates for the required return for contracts operating four hours per day across all distances.

16.6. UPDATING COSTS TO CURRENT DOLLARS

A constant failure of the reimbursement system has been its historical nature. The operator is paid instalments that reflect the market in the preceding year in the dollars of that year. The current PwC method indicates that for the 2003/2004 contract period the operator is paid for the changes in costs that occurred over the 2002/2003 period. To address this inadequacy requires a year of 'catch up'. Each year is updated to redress any failure of the predictors plus further predictive factors for the next year. Assuming that the updating of costs was to occur in 2003: this involves the application

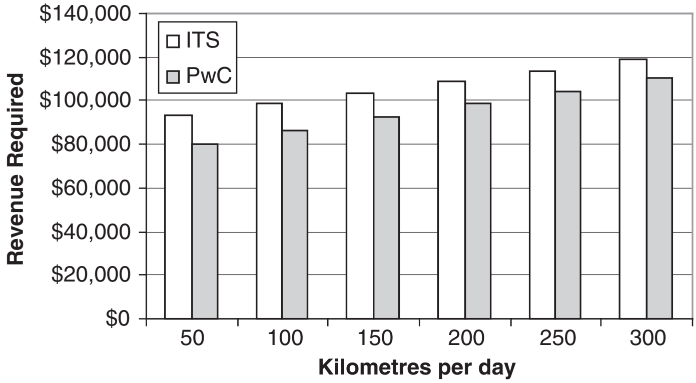


Fig. 16.2. Required Revenue for a Category Four Contract Operating for Four Hours per Day, across Six Distances, the ITS Model Compared to the PwC Model, 2003 Dollars.

of the historical measures to 2002 data to bring costs up to 2003 dollars, and then applying additional factors to bring inputs up to 2004 dollars in real terms. Then, in 2004 a review of the effectiveness of the previous year's predictive measures instituted with over-(under-)estimations is determined and included in the predictive factors, to move to 2005 dollars. This process would result in a larger than normal rise in the first year. In the next section, we discuss appropriate measures to factor future price changes, using the example of updating 2003 data into 2004 dollars. The implementation of the factoring is easily achievable within the ITS model. The BCA has advised that the updating of the model to current dollars will not take place in this period. The BCA would like this issue explored in subsequent periods. To this end ITS has proposed the following method.

16.6.1. Risk

Just as the general economic climate ebbs and flows, the risk associated with the operation of the contract varies from one year to the next. However, due to the nature of the bus industry it is exceedingly difficult to measure such deviations. The two quantifiable measures of risk can, however, be equated. The risk afforded large stock exchange listed companies is a matter of public record through ACCC and IPART publications, and any deviation from 6% can and should be included in the risk premium. The risk associated with the cost of servicing the capital debt is the difference between the forecast 10-year government bond rate and the forecast five-year fixed-term loan rate. The risk premium should at least equal the addition of this differential. This rate, it is argued, does not fully include the prohibitive capital costs inherent in the bus and coach industry under current average age laws and the large level of risk associated with smaller businesses.

16.6.2. Real Rate of Interest or Risk-Free Investment Amount

The implementation of a forecast for the 10-year government bond rate to move the 2003 submission into 2004 dollars is a valid approach. Whether the interest rate at the time of submission was used or a forecast used, there is the possibility to redress any inaccuracies at the next contract reimbursement determination.

16.6.3. Loan Rate

Two approaches can be taken towards the updating of the loan rate into 2004 dollars. A valid approach would be to use a forecast provided by a reputable financial institution. Equally valid would be the use of a current figure. Loan rates are difficult to forecast. The method of providing an adjustment to account for any inaccuracies at the next contract reimbursement determination acts as a safety net for either approach.

16.6.4. CPI

An industry forecast for the proceeding year should be used. This has already been done, albeit on a smaller scale, in previous submissions. CPI should be applied to all applicable cost items. It does not apply to wage rates and fuel costs which are indexed according to existing awards or by agreement in respect of the movement of fuel prices. However, extreme market movements must be heeded. An example of this may be tension surrounding war, driving up the cost of lubricant. Such a rise would not be fully accounted for by CPI and would require a separate indexation.

16.6.5. Fuel Price

The preceding year's fuel component of CPI should be used to factor 2003 fuel costs to 2004 dollars. The overall CPI rate does not adequately reflect changes in fuel price.

16.6.6. Residual Rate

The residual rate for each type of contract category would remain the same, subject to any changes in the market.

16.6.7. Capital Cost

The most appropriate method to factor the 2003 capital cost of the vehicle to future 2004 dollars is through the application of CPI. For the 2005 determination, 2004 capital costs should be sought and then subjected to a CPI adjustment.

16.6.8. Component Costs

The use of a CPI forecast is generally appropriate to factor in underlying cost changes in applicable bus-related costs and distance-related costs. Fuel prices have been identified as an exception. Attention must be paid to extraneous market forces. Global or local events may impact upon the prices of specific goods above or below the influence of CPI. If such a forecast for the price change of a given product can be justified, an in(de)crease must be factored into the model. The BCA has received information that lubricant prices have risen by an average of 4% on the 1st of February 2003. On this occasion, the increase is above inflation and should be factored into the 2003 reimbursement.

16.6.9. Wage Rates

The current method of utilising the award rates of pay should continue. However, award determinations sometimes occur after the input factors have been determined. The lost costs borne as a consequence of this must be factored into the next year model. An extra cost per hour for each award type should be entered into the wage sheet.

16.7. SUMMARY

The ITS model is put forward herein as a replacement for the current PwC model. The ITS model was configured cognisant of the concerns IPART and the BCA (NSW) had in the PwC model. In response to these concerns ITS has critically examined the depreciation method used by the PwC model and adopted an ACC approach, which better accounts for the replacement cost of the vehicle. ITS has put forward and presented a defensible argument for the risk premium. Utilising survey data, this report shows that the costs detailed in the ITS model are up-to-date and better reflect the post-GST implementation economy. This report sets out the requirements necessary to update the ITS model so that bus operators are reimbursed in current dollars. ITS found that there was no statistically significant relationship between running on loose surface roads and vehicle repairs and maintenance costs, given the available data. In addition to the considerations of the reimbursement of non-commercial contracts, ITS has provided KPIs for both commercial and non-commercial contracts.

In the ITS model the BCA has, in our opinion, a very defensible non-commercial contract reimbursement method that it can take to IPART.

APPENDIX 16A. NON-COMMERCIAL CONTRACT COST INDEX SURVEY WITH NOTES

Distributed to operators October 2002, comments in bold italics (for future revision)

Company name: ______________________________

Contract number: ______________________________

Industry KPIs for Non-commercial Contract

This information relates to **only one contract**. Where an operator has more than one contract, shared costs such as administration costs etc., should be divided equally among the number of contracts operated.

****include depreciation of vehicle somewhere so that they do not include in 'other'***
****state whether or not includes GST***

Period: 12 months ended 30 June 2002

Questions	
Contract Details	
1. School operating days	……………………..…..days
2. Contract kilometres per day	……………………..………kms
2A. Actual kilometres per day ***needed to fulfill contract***	………………….………kms
3. Contract operating hours per day	……………………………hrs
3A. Actual operating hours per day ***needed to fulfill contract***	……………………………hrs
4. Bus category being paid for	Category……………………
4A. Bus category actually being used	Category……………………
A. Staff Costs ***reiterate per contract throughout***	
A1. Annual cleaning hours (for bus)	Hrs …………………………
A2. Annual administration hours (include hours spent on contract compliance, records, customer complaints, child protection, accounts, liaison with schools ***DAFGS admin***, etc.).	Hrs …………………………
A3. Do you pay driver/conductor allowance?	Y / N. If yes, when is the allowance paid, for example for every day or only when cash fares are collected…………………….
B. Insurance and registration Annual cost of:	
B1. Greenslip	$……………..…..………p.a.
B2. Registration	$……………..…..………p.a.
B3. Comprehensive insurance premium	$……………..…..………p.a.
B4. Other Insurances (e.g., public liability)	$……………..…..………p.a.
B5. Market value of vehicle	$………..…***delete p.a***.….p.a.

C. <u>Fuel, oil, lubricants</u>	
Oil referred to in heading but not in text	
C1. Litres of fuel consumed in the year	…………...……………Litres
C2. Average fuel price, exclude DAFGS (based over a 12 month period) ***provide numerical example***	$………...……………/Litres
C2A. If not known indicate total cost of fuel for 12 months, exclude DAFGS	$……………………………
C3. Are you eligible for DAFGS?	Y / N
C4. Diesel/petrol	D / P
C5. Annual cost of lubricants (if not included in D1)	$ ……………………………..
C6. Annual cost of tyres	$ ……………………………..
C7. What are the total kilometres travelled in the year (i.e., include charter, etc.)?	…………………………..kms
D. <u>Bus repairs and maintenance</u>	
D1. Costs per year for parts and labour incurred in maintaining and servicing of vehicle (exclude item D2).	$………………...……..…..
D2. If you do your own maintenance and servicing, how many hours per year is spent on these tasks?	
- yourself	………………………….. hrs
- your own company mechanic	………………………….. hrs
E. <u>Administration costs</u> – applicable to the contract (If you have more than one contract divide these total costs by the number of contracts) ***Advertising?***	
E1. BCA membership	$………………...……..….
E2. Accounting/audit fees	$………………...……..….
E3. Bank charges	$………………...……..….
E4. Cleaning materials	$………………...……..….
E5. Computer consumables (e.g., ribbons, ink cartridges etc.)	$………………...……..….
E6. Computer software (e.g., MYOB or other packages)	$………………...……..….
E7. Conference and seminar costs (air fares accommodation, meals etc.)	$………………...……..….
E8. Courier and freight (if not included in maintenance cost)	$………………...……..….
E9. Electricity/gas	$………………...……..….
E10. HVIS costs	$………………...……..….
Some operators included in rego, is this applicable?	
E11. Land tax	$………………...……..….
Confusion between land tax and E17 rates	

E12. Legal fees	$……………………..……..….
E13. Motor vehicle use (directly applicable to your bus business, e.g., trips to TNSW, schools, pick up parts, conferences, etc. Use 55 cents/km).	$……………………..……..….
Including survey vehicles	
E14. OH&S management systems	$……………………..……..….
E15. Postage	$……………………..……..….
E16. Printing (of timetable, brochures for schools, etc.)	$……………………..……..….
Need to differentiate from E25	
E17. Rates	$……………………..……..….
Includes water rates?	
E18. Rent – premises (e.g., bus parking and/or office)	$……………………..……..….
E19. Repairs and maintenance–premises	$……………………..……..….
E20. Security (for depot and/or office)	$……………………..……..….
E21. Signage (if not included in repairs and maintenance, e.g., school bus signs)	$……………………..……..….
E22. Sponsorship and donations (to schools only)	$……………………..……..….
E23. Staff amenities and supplies (e.g., coffee, biscuits, hand towels)	$……………………..……..….
E24. Staff recruitment costs (advertising)	$……………………..……..….
E25. Stationery (bus passes, pens, paper, etc.)	$……………………..……..….
E26. Subscriptions (truck and bus, ABC, etc.)	$……………………..……..….
E27. Telephone/fax/mobile	$……………………..……..….
Combine e27&e28 due to rise in bundling	
E28. Internet	$……………………..……..….
E29. Towing (if not included in repairs and maintenance)	$……………………..……..….
E30. Training (other than E7)	$……………………..……..….
E31. Uniforms (provision and laundry)	$……………………..……..….
E32. Waste disposal and EPA costs	$……………………..……..….
Water costs – rates	
E33. Other. Please specify …………………………	$……………………..……..….
Depreciation (original cost divided by 5 years) of:	
E34. Surveillance systems (e.g., video camera)	$……………………..……..….
E35. Communication equipment (two ways, mobiles)	$……………………..……..….
E36. Computer hardware, office equipment	$……………………..……..….
E37. Other plant and equipment (e.g., workshop equipment)	$……………………..……..….

F. <u>Bus costs and vehicle details</u>	
F1. How is vehicle financed?	
Should be, is, or WAS financed	
- Hire Purchase	Y / N
- Lease	Y / N
- Purchased outright	Y / N
If hire purchased/leased, what is residual value?	$.................................
F2. What is the annual repayment total?	$.................................
F3. What time period is finance over?	................................yrs
F4. Was security required (other than the bus)?	Y / N
F5. Next contract anniversary date	.... / .... / ....
F6. Age of vehicle at that date	................................yrs
F7. Current average age of fleet if you have more than one non-commercial contract (as at 1 November 2002)	................................yrs
F8. What was the age of the bus at purchase?	................................yrs
F9. What was the cost of purchase and any initial repairs/ improvements?	$.................................
F10. What was the year of acquisition?	....
F11. What make/type of vehicle do you operate?	....
F12. What is its seating capacity?	....
F13. What is its three for two capacity?	....
F14. What is its licensed standees?	....
F15. Does vehicle have seat belts?	Y / N
F16. Is the vehicle air-conditioned?	Y / N
F17. What spare vehicle arrangements do you have?	Borrow/hire?.................. Other – please specify..........
F18. On how many days in the year was it necessary to use a spare vehicle for breakdowns or servicing problems? ***Include cost associated with spare***	....days
G. <u>Other costs</u>	
G1. Are there any other costs associated with operating your non-commercial contract?	Y / N
Please specify...	$.......................per year
G2. Depot costs incurred in complying with:	
- OH&S	$.................................
- EPA (if not included in E32) ***E32 should refer to bus costs only – not depot costs***	$.................................
- Local government ***provide example***	$.................................
- Licensing of mechanical equipment	$.................................
- Other (please specify)	$.................................
G3. Do you pay payroll tax?	Y / N

H. <u>Contract details</u>	
H1. Contract holders name	………………………….……….……
H2. Contract renewal date	….….. / ……... / ……...
H3. Contact phone number	………………………….……….……
I. <u>Revenue (inclusive of GST)</u>	
I1. What is your 2002/2003 financial year revenue from TNSW for this contract?	$……………..…..…………
I2. What is your annual revenue from other sources?	$…………….……….(charter)
	$………………...(cash fares)
I4. Other (please specify e.g., advertising on bus)	$………………..……….…….
……………………………………………………….	$………………..……….…….
……………………………………………………….	$………………..……….…….
……………………………………………………….	$………………..……….…….
Total other:	
J. <u>Vehicle use</u>	
Is vehicle regularly used to perform trips on other contracted bus services e.g., commercial country town, village to town or town to town services?	Y / N
If YES, what percentage of total kms would this represent?	……………………………%
Rethink question - not answered in current version ***Aim of question unclear***	
K. General	
What other factors influence your costs e.g., road surfaces, traffic/operational difficulties, other (please specify), and how would you calculate the added costs per year?	……………………………… ……………………………… ……………………………… ………………………………
Ask for percent loose surface road on contract route and percent of repairs and maintenance costs at 'D' attributable to loose road surface (this should jog their memories so they make sure to include gravel costs at D)	

APPENDIX 16B. ITS MODEL: ACC WORKSHEET

Annualised Capital Cost (ACC) and Risk Factor Working – Non Commercial Category 2, 2002

Factors	
This year	2002
Real rate of interest	6.32%
Economic life	10
Residual rate	15.00%
Typical vehicle	Toyota coaster
Risk factor	8.00%
CPI	2.93%

Capital cost (2002, $)	Age of vehicle															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	83,000	69,000	62,000	54,000	46,000	40,000	35,000	32,000	26,000	22,000	18,000	12,000	9,000	7,000	6,000	5,000

ACC (2002, $)	Age of vehicle															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	9,731	8,743	8,594	8,316	8,032	8,142	8,649	10,236	12,108	19,882	0.00	0.00	0.00	0.00	0.00	0.00

Proportion of vehicles by age (from survey data) (2002, %)										
	5.56	7.41	3.70	11.11	9.26	20.37	9.26	12.96	5.56	14.81

ACC weighted average by age (2002, $)										
	540.63	647.65	318.31	924.01	743.67	1,658.53	800.80	1,326.90	672.68	2,945.46

Totals (2002)	Total_ACC	Risk	Total revenue required
	10,578.63	3,401.48	13,980.11

APPENDIX 16C. BUSINESS LOAN RATES

Institution	Product Name Assumed: Non-Residentially Secured	Variable Rate	Fixed-Term Rates (%)			Fees	
			3 years	4 years	5 years	Establishment	Line
ANZ Bank	Commercial loan	7.55	6.82	7.31	7.61	7.8	8
ANZ Bank	Commercial loan	7.55	6.82	7.31	7.61	7.8	8
BankWest	Business loan-affinity commercially secured	7.29	7.45	7.57	7.68	7.85	7.97
BankWest	Business loan-originator commercially secured	7.29	7.45	7.57	7.68	7.85	7.97
Citibank	Commercial mortgage rates	7.59	6.99	7.09	7.29	7.29	7.39
Citibank	Citibank business loan	7.59	7.39	7.49	7.79	7.79	7.79
RESI Mortgage Corporation	Commercial property loan	7.21	6.55	6.65	6.8	6.95	7.1
Suncorp	Business	7.42	6.9	7	7.1	7.2	7.3
Westpac Banking Corporation	Business development loan	6.65	5.9	6.02	6.15	6.27	6.37
Westpac Banking Corporation	Business development loan	6.65	6.35	6.47	6.6	6.72	6.82
Adelaide Bank		7.45	6.63	6.73	6.85	7	7.12
Arab Bank Australia Ltd		7.7	8	8.2	8.3	8.32	8.35

Bank of Melbourne		7.4	6.19	6.29	6.41	6.54	6.66
Challenge Bank		7.4	6.19	6.29	6.41	6.54	6.66
Commonwealth Bank		7.55	6.35	6.3	6.6	6.65	6.75
Greater Building Society		7.4	6.49	6.75	6.8	6.9	7.05
Grenfell Securities		–	9.5	9.5	9.5	–	9.5
ING Bank		6.85	6.75	6.85	7.0	7.15	7.25
National Australia Bank		7.75	6.57	6.76	6.87	6.99	7.09
Savings and Loans CU (SA)		7.07	6.49	6.69	6.69	6.99	6.99
SUNCORP		7.42	6.9	7	7.1	7.2	7.3
ANZ Bank	Commercial loan	7.55	6.82	7.31	7.61	7.8	8.0
Leasing Institution	Commercial hire purchase over $57,009, national		3 years 40% residence	4 years 30% residence	5 years 20% residence		
St. George			8.7	8.7	8.6		
Bendigo Bank Ltd			7.0	7.05	7.1		
Bank SA			7.7	7.7	7.75		
	Average (%)	7.34	7.26	7.27	7.45		

Source: http://www.infochoice.com.au/banking/default.asp?CategoryID=92, http://www.infochoice.com.au/banking/default.asp?CategoryID=96, accessed 28 April 2003, and http://www.cannex.com.au/surveys/busloan.html, accessed 28 April 2003.

APPENDIX 16D. ITS MODEL AND PWC MODEL SUMMARY SHEETS, 2002

The ITS Model Summary Sheet

Institute of transport studies model (2002)

	Category 4
1. To be input by operator	
a. Kilometers per day	100
b. Hours per day	4.00
c. Number of contract days	201
d. Eligible for DAFGS	☑ Click if yes
Total revenue required per bus	$97,122
GST Component	$8,829
Net revenue required per bus	$88,293
2. Cost components dependant on operator inputs	
a. Fuel-related costs	$0.196
b. Bus-related costs	$26,490
c. Other distance-related costs	$0.235
d. Driver-related costs – per hour	$22.127
– per day	$10.304

Calculation of revenue required per bus	
1. Costs	
Bus-related costs	$26.490
Driver-related costs per hour	$17,790
Driver-related costs per day	$2,071
Fuel-related costs	$3,935
Other distance-related costs	$4,726
	$55,012
2. Required return	
ACC including risk free interest	$19,020
Risk premium	$11,236
Spare bus allowance and ACC and risk on spares (10%)	$3,026
	$33,281
Net revenue required per bus	$88,293
GST Applicable	$8,829
Total revenue required per bus	$97,122

Notes	
Annual inflation (sydney CPI)	2.9%
10 year bond rate	6.32%
Risk premium	8.00%
Spare bus allowance+ ACC and risk on spares	10.00 %

Pricewaterhousecoopers model compliance with average age	
For the year	Sydney UNI Category 4 Mercedes
1. To be input by operator	
a. Kilometers per day	100.00
b. Hours per day	4.00
c. Eligible for DAFGS	☑ Click if yes
Total revenue required per bus	84,119
GST	7,647
Net revenue required per bus	76,471
2. To be input by pricewaterhousecoopers	
a. Spare bus allownce	10%
b. Fuel-related costs	$10.170
c. Bus-related costs	$18,209
d. Other distance-related costs	$0.354
e. Driver-related costs – per hour	$22.128
– per day	$9.495
f. Number of days per year	201
g. Depreciation rate	11.5%
h. ROI rate	14.32%
i. Residual value of bus	5%
j. Number of buses	24
k. Average bus age (years)	12

Calculation of revenue required per bus	Category 4 $
1. Costs	
Depreciation	6,691
Depreciation (spare bus allow)	669
Bus-related costs	18,209
Driver-related costs per hour	17,791
Driver-related costs per day	1,908
Fuel-related costs	3,423
Other distance-related costs	7,109
	55,801
2. Required return	
Return on investment	18,791
Return on investment on spares(10%)	1,879
	20,670
Net revenue required per bus	76,471
GST applicable	7,647
Total revenue required per bus	84,119

Notes	
Annual Inflation (Sydney CPI)	2.9%
10-year bond rate	6.32%

APPENDIX 16E. ITS MODEL AND PWC MODEL SUMMARY SHEETS, 2003

The ITS Model Summary Sheet

Institute of transport studies model (2003)	Category 4
1. To be input by operator	
a. Kilometers per day	100
b. Hours per day	4.00
c. Number of contract days	201
d. Eligible for DAFGS	☑ Click if yes
Total revenue required per bus	$98,527
GST Component	$8,957
Net revenue required per bus	$89,570
2. Cost components dependant on operator inputs	$
a. Fuel-related costs	0.219
b. Bus-related costs	27,415
c. Other distance-related costs	0.242
d. Driver-related costs – per hour	22.999
– per day	10.304

Calculation of revenue required per bus	
1. Costs	$
Bus-related costs per day	27.415
Driver-related costs per hour	18,491
Driver-related costs per day	2,071
Fuel-related costs	4,397
Other-distance-related costs	4,866
	57,240
2. Required return	$
ACC including risk free interest	18,428
Risk premium	10,963
Spare bus allowance and ACC and risk on spares	2,939
	32,330
Net revenue required per bus	89,570
GST applicable	8,957
Total revenue required per bus	98,527
Notes	
Annual inflation (Sydney CPI)	3.91%
10 year bond rate	5.65%
Risk premium	7.81%
CPI fuel component	9.21%
Spare bus allown + ACC and risk on spares	10.00 %

Pricewaterhousecoopers Model Compliance with Average Age

For the year	Sydney UNI Category 4 Mercedes
1. To be input by operator	
a. Kilometers per day	100.00
b. Hours per day	4.00
c. Eligible for DAFGS	☑ Click if yes
Total revenue required per bus	$86,398
GST	$7,854
Net revenue required per bus	$78,544
2. To be input by pricewaterhousecoopers	
a. Spare bus allownce	10%
b. Fuel-related costs	$0.175
c. Bus-related costs	$18,922
d. Other distance-related costs	$0.368
e. Driver-related costs – per hour	$22.999
– per day	$9.494
f. Number of days per year	201
g. Depreciation rate	11.5%
h. ROI rate	13.33%
i. Residual value of bus	5%
j. Number of buses	24
k. Average bus age (years)	12
l. Bus safety package	

Calculation of Revenue required per bus

	Category 4 $
1. Costs	
Depreciation	7,197
Depreciation (spare bus allow)	720
Bus-related costs	18,922
Driver-related costs per hour	18,491
Driver-related costs per day	1,908
Fuel-related costs	3,527
Other distance-related costs	7,388
	58,152
2. Required return	
Return on investment	18,538
Return on investment on spares (10%)	1,854
	20,391
Net revenue required per bus	78,544
GST applicable	7,854
Total revenue required per bus	86,398

Notes

Annual in ation (Sydney CPI)	3.9%
10 year bond rate	5.33%

APPENDIX 16F. TOTAL REVENUE REQUIRED PER BUS, PWC MODEL VS. ITS MODEL, $, 2002, BY CONTRACT CATEGORY

Kilometres	DAFGS el.	Model	1.5 h ($)	2 h ($)	2.5 h ($)	3 h ($)	3.5 h ($)	4 h ($)	4.5 h ($)	5 h ($)	5.5 h ($)	6 h ($)
Category 1												
50	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	36,613	39,059	41,505	43,951	46,397	48,843	51,289	53,735	56,182	58,628
	No	PwC	31,840	37,471	39,917	42,363	44,809	47,256	49,702	52,148	54,594	57,041
		ITS	36,687	39,133	41,579	44,025	46,471	48,917	51,363	53,809	56,256	58,702
100	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	39,447	41,893	44,339	46,785	49,232	51,678	54,124	56,570	59,016	61,462
	No	PwC	38,367	40,813	43,260	45,706	48,152	50,598	53,045	55,491	57,937	60,383
		ITS	39,914	42,361	44,807	47,253	49,699	52,145	54,591	57,037	59,483	61,930
150	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	42,282	44,728	47,174	49,620	52,066	54,512	56,958	59,405	61,851	64,297
	No	PwC	41,710	44,156	46,602	49,048	51,495	53,941	56,387	58,833	61,280	63,726
		ITS	43,142	45,588	48,035	50,481	52,927	55,373	57,819	60,265	62,711	65,157
200	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	45,116	47,562	50,009	52,455	54,901	57,347	59,793	62,239	64,685	67,131
	No	PwC	45,052	47,499	49,945	52,391	54,837	57,284	59,730	62,176	64,622	67,069
		ITS	46,370	48,816	51,262	53,709	56,155	58,601	61,047	63,493	65,939	68,385
250	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	47,951	50,397	52,843	55,289	57,735	60,182	62,628	65,074	67,520	69,966
	No	PwC	48,395	50,841	53,288	55,734	58,180	60,626	63,073	65,519	67,965	70,411
		ITS	49,598	52,044	54,490	56,936	59,383	61,829	64,275	66,721	69,167	71,613
300	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	50,785	53,232	55,678	58,124	60,570	63,016	65,462	67,908	70,355	72,801
	No	PwC	51,738	54,184	56,630	59,076	61,523	63,969	66,415	68,861	71,308	73,754
		ITS	52,826	55,272	57,718	60,164	62,610	65,057	67,503	69,949	72,395	74,841

Category 2												
50	Yes	PwC	43,340	45,786	48,232	50,679	53,125	55,571	58,017	60,464	62,910	65,356
		ITS	48,992	51,439	53,885	56,331	58,777	61,223	63,669	66,115	68,561	71,008
	No	PwC	42,977	45,423	47,870	50,316	52,762	55,208	57,655	60,101	62,547	64,993
		ITS	47,869	50,315	52,761	55,207	57,653	60,099	62,545	64,992	67,438	69,884
100	Yes	PwC	46,535	48,981	51,427	53,874	56,320	58,766	61,212	63,659	66,105	68,551
		ITS	52,613	55,059	57,506	59,952	62,398	64,844	67,290	69,736	72,182	74,628
	No	PwC	46,512	48,959	51,405	53,851	56,297	58,744	61,190	63,636	66,082	68,529
		ITS	51,951	54,398	56,844	59,290	61,736	64,182	66,628	69,074	71,520	73,967
150	Yes	PwC	49,730	52,176	54,622	57,068	59,515	61,961	64,407	66,853	69,300	71,746
		ITS	56,234	58,680	61,126	63,573	66,019	68,465	70,911	73,357	75,803	78,249
	No	PwC	50,048	52,494	54,940	57,386	59,833	62,279	64,725	67,171	69,618	72,064
		ITS	56,034	58,480	60,926	63,373	65,819	68,265	70,711	73,157	75,603	78,049
200	Yes	PwC	52,925	55,371	57,817	60,263	62,710	65,156	67,602	70,048	72,495	74,941
		ITS	59,855	62,301	64,747	67,193	69,640	72,086	74,532	76,978	79,424	81,870
	No	PwC	53,583	56,029	58,475	60,922	63,368	65,814	68,260	70,707	73,153	75,599
		ITS	60,117	62,563	65,009	67,455	69,901	72,348	74,794	77,240	79,686	82,132
250	Yes	PwC	56,120	58,566	61,012	63,458	65,904	68,351	70,797	73,243	75,689	78,136
		ITS	63,476	65,922	68,368	70,814	73,260	75,707	78,153	80,599	83,045	85,491
	No	PwC	57,118	59,564	62,011	64,457	66,903	69,349	71,796	74,242	76,688	79,134
		ITS	64,200	66,646	69,092	71,538	73,984	76,430	78,876	81,323	83,769	86,215
300	Yes	PwC	59,314	61,761	64,207	66,653	69,099	71,546	73,992	76,438	78,884	81,331
		ITS	67,097	69,543	71,989	74,435	76,881	79,327	81,774	84,220	86,666	89,112
	No	PwC	60,654	63,100	65,546	67,992	70,438	72,885	75,331	77,777	80,223	82,670
		ITS	68,282	70,728	73,175	75,621	78,067	80,513	82,959	85,405	87,851	90,298

APPENDIX 16F. (*Continued*)

Kilometres	DAFGS el.	Model	1.5 h ($)	2 h ($)	2.5 h ($)	3 h ($)	3.5 h ($)	4 h ($)	4.5 h ($)	5 h ($)	5.5 h ($)	6 h ($)
Category 3												
50	Yes	PwC	54,171	56,618	59,064	61,510	63,956	66,403	68,849	71,295	73,741	76,188
		ITS	68,732	71,178	73,624	76,070	78,516	80,962	83,408	85,855	88,301	90,747
	No	PwC	53,963	56,410	58,856	61,302	63,748	66,195	68,641	71,087	73,533	75,980
		ITS	69,200	71,646	74,092	76,538	78,984	81,431	83,877	86,323	88,769	91,215
100	Yes	PwC	59,097	61,543	63,989	66,436	68,882	71,328	73,774	76,220	78,667	81,113
		ITS	73,076	75,522	77,968	80,414	82,861	85,307	87,753	90,199	92,645	95,091
	No	PwC	59,384	61,830	64,276	66,723	69,169	71,615	74,061	76,508	78,954	81,400
		ITS	74,013	76,459	78,905	81,351	83,797	86,243	88,689	91,136	93,582	96,028
150	Yes	PwC	64,022	66,468	68,915	71,361	73,807	76,253	78,700	81,146	83,592	86,038
		ITS	77,421	79,867	82,313	84,759	87,205	89,651	92,097	94,543	96,990	99,436
	No	PwC	64,805	67,251	69,697	72,143	74,590	77,036	79,482	81,928	84,375	86,821
		ITS	78,825	81,271	83,718	86,164	88,610	91,056	93,502	95,948	98,394	100,840
200	Yes	PwC	68,948	71,394	73,840	76,286	78,733	81,179	83,625	86,071	88,518	90,964
		ITS	81,765	84,211	86,657	89,103	91,549	93,996	96,442	98,888	101,334	103,780
	No	PwC	70,225	72,671	75,118	77,564	80,010	82,456	84,903	87,349	89,795	92,241
		ITS	83,638	86,084	88,530	90,976	93,423	95,869	98,315	100,761	103,207	105,653
250	Yes	PwC	73,873	76,319	78,766	81,212	83,658	86,104	88,551	90,997	93,443	95,889
		ITS	86,109	88,556	91,002	93,448	95,894	98,340	100,786	103,232	105,678	108,125
	No	PwC	75,646	78,092	80,538	82,984	85,431	87,877	90,323	92,769	95,216	97,662
		ITS	88,451	90,897	93,343	95,789	98,235	100,681	103,127	105,574	108,020	110,466
300	Yes	PwC	78,798	81,245	83,691	86,137	88,583	91,030	93,476	95,922	98,368	100,815
		ITS	90,454	92,900	95,346	97,792	100,238	102,684	105,131	107,577	110,023	112,469
	No	PwC	81,066	83,513	85,959	88,405	90,851	93,298	95,744	98,190	100,636	103,082
		ITS	93,263	95,710	98,156	100,602	103,048	105,494	107,940	110,386	112,832	115,279

Category 4												
50	Yes	PwC	66,095	68,541	70,987	73,434	75,879	78,326	80,772	83,218	85,665	88,111
		ITS	80,128	82,574	85,020	87,466	89,913	92,359	94,805	97,251	99,697	102,143
	No	PwC	65,951	68,397	70,843	73,290	75,735	78,181	80,628	83,074	85,521	87,967
		ITS	80,727	83,173	85,619	88,065	90,512	92,958	95,404	97,850	100,296	102,742
100	Yes	PwC	71,887	74,334	76,780	79,226	81,673	84,119	86,565	89,011	91,457	93,904
		ITS	84,892	87,338	89,784	92,230	94,676	97,122	99,568	102,014	104,461	106,907
	No	PwC	72,307	74,753	77,199	79,646	82,092	84,538	86,985	89,431	91,876	94,323
		ITS	86,089	88,535	90,981	93,427	95,873	98,319	100,765	103,211	105,658	108,104
150	Yes	PwC	77,680	80,126	82,573	85,019	87,465	89,912	92,357	94,804	97,250	99,696
		ITS	89,655	92,101	94,547	96,993	99,440	101,886	104,332	106,778	109,224	111,670
	No	PwC	78,663	81,110	83,556	86,002	88,449	90,894	93,341	95,787	98,233	100,680
		ITS	91,451	93,897	96,343	98,789	101,235	103,682	106,128	108,574	111,020	113,466
200	Yes	PwC	83,472	85,919	88,365	90,812	93,258	95,704	98,150	100,597	103,043	105,489
		ITS	94,419	96,865	99,311	101,757	104,203	106,649	109,095	111,541	113,988	116,434
	No	PwC	85,020	87,467	89,912	92,358	94,805	97,251	99,697	102,143	104,590	107,036
		ITS	96,813	99,259	101,705	104,151	106,598	109,044	111,490	113,936	116,382	118,828
250	Yes	PwC	89,266	91,712	94,158	96,604	99,051	101,497	103,943	106,389	108,836	111,282
		ITS	99,182	101,628	104,074	106,520	108,967	111,413	113,859	116,305	118,751	121,197
	No	PwC	91,376	93,822	96,269	98,715	101,161	103,607	106,054	108,500	110,946	113,392
		ITS	102,175	104,621	107,067	109,514	111,960	114,406	116,852	119,298	121,744	124,190
300	Yes	PwC	95,058	97,505	99,951	102,397	104,843	107,290	109,736	112,182	114,628	117,075
		ITS	103,946	106,392	108,838	111,284	113,730	116,176	118,622	121,068	123,515	125,961
	No	PwC	97,733	100,179	102,625	105,071	107,518	109,964	112,410	114,856	117,303	119,749
		ITS	107,537	109,983	112,430	114,876	117,322	119,768	122,214	124,660	127,106	129,552

APPENDIX 16G. TOTAL REVENUE REQUIRED PER BUS, PWC MODEL VS. ITS MODEL, $ 2003, BY CONTRACT CATEGORY

Kilometres	DAFGS el.	Model	1.5 h ($)	2 h ($)	2.5 h ($)	3 h ($)	3.5 h ($)	4 h ($)	4.5 h ($)	5 h ($)	5.5 h ($)	6 h ($)
Category 1												
50	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	37,566	40,109	42,651	45,194	47,736	50,279	52,821	55,364	57,906	60,449
	No	PwC	36,012	38,554	41,097	43,639	46,182	48,724	51,267	53,809	56,352	58,894
		ITS	37,639	40,182	42,724	45,267	47,809	50,352	52,894	55,437	57,979	60,522
100	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	40,611	43,154	45,696	48,239	50,781	53,324	55,866	58,409	60,951	63,494
	No	PwC	39,464	42,007	44,548	47,091	49,633	52,176	54,718	57,262	59,804	62,347
		ITS	41,077	43,620	46,162	48,705	51,247	53,790	56,332	58,875	61,417	63,960
150	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	43,657	46,199	48,742	51,284	53,826	56,369	58,911	61,454	63,996	66,539
	No	PwC	42,916	45,459	48,000	50,543	53,085	55,629	58,171	60,714	63,256	65,799
		ITS	44,516	47,058	49,601	52,143	54,686	57,228	59,771	62,313	64,856	67,398
200	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	46,702	49,244	51,787	54,329	56,872	59,414	61,957	64,499	67,041	69,584
	No	PwC	46,368	48,911	51,452	53,996	56,538	59,081	61,623	64,166	66,708	69,251
		ITS	47,954	50,497	53,039	55,582	58,124	60,667	63,209	65,752	68,294	70,837
250	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	49,747	52,289	54,832	57,374	59,917	62,459	65,002	67,544	70,087	72,629
	No	PwC	49,820	52,364	54,905	57,448	59,990	62,533	65,075	67,618	70,160	72,704
		ITS	,392	53,935	56,477	59,020	61,562	64,105	66,647	69,190	71,732	74,275
300	Yes	PwC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		ITS	52,792	55,334	57,877	60,419	62,962	65,504	68,047	70,589	73,132	75,674
	No	PwC	53,273	55,816	58,357	60,900	63,442	65,985	68,527	71,070	73,613	76,156
		ITS	54,831	57,373	59,916	62,458	65,001	67,543	70,086	72,628	75,171	77,713

Category 2												
50	Yes	PwC	44,633	47,176	49,718	52,261	54,803	57,346	59,888	62,431	64,973	67,516
		ITS	49,856	52,398	54,941	57,483	60,026	62,568	65,111	67,653	70,196	72,738
	No	PwC	44,243	46,786	49,327	51,871	54,413	56,956	59,498	62,041	64,583	67,126
		ITS	48,725	51,268	53,810	56,353	58,895	61,438	63,980	66,523	69,065	71,608
100	Yes	PwC	47,943	50,486	53,028	55,571	58,113	60,656	63,198	65,741	68,283	70,827
		ITS	53,729	56,271	58,814	61,356	63,899	66,441	68,984	71,526	74,069	76,611
	No	PwC	47,893	50,437	52,978	55,521	58,063	60,606	63,148	65,691	68,233	70,777
		ITS	53,060	55,603	58,145	60,688	63,230	65,773	68,315	70,858	73,400	75,943
150	Yes	PwC	51,253	53,796	56,337	58,881	61,423	63,966	66,508	69,051	71,593	74,136
		ITS	57,602	60,145	62,687	65,230	67,772	70,315	72,857	75,400	77,942	80,485
	No	PwC	51,544	54,087	56,628	59,171	61,714	64,257	66,799	69,342	71,884	74,427
		ITS	57,396	59,938	62,481	65,023	67,566	70,108	72,651	75,193	77,736	80,278
200	Yes	PwC	54,563	57,106	59,647	62,190	64,733	67,276	69,818	72,361	74,903	77,446
		ITS	61,476	64,018	66,561	69,103	71,646	74,188	76,731	79,273	81,816	84,358
	No	PwC	55,194	57,737	60,278	62,821	65,364	67,907	70,449	72,992	75,534	78,077
		ITS	61,731	64,273	66,816	69,358	71,901	74,443	76,986	79,528	82,071	84,613
250	Yes	PwC	57,873	60,416	62,957	65,500	68,042	70,585	73,127	75,670	78,212	80,756
		ITS	65,349	67,891	70,434	72,976	75,519	78,061	80,604	83,146	85,689	88,231
	No	PwC	58,844	61,388	63,929	66,472	69,014	71,557	74,099	76,642	79,184	81,728
		ITS	66,066	68,608	71,151	73,693	76,236	78,778	81,321	83,863	86,406	88,948
300	Yes	PwC	61,183	63,726	66,267	68,811	71,353	73,896	76,438	78,981	81,523	84,066
		ITS	69,222	71,765	74,307	76,850	79,392	81,935	84,477	87,020	89,562	92,105
	No	PwC	62,495	65,038	67,579	70,123	72,665	75,208	77,750	80,293	82,835	85,378
		ITS	70,401	72,944	75,486	78,029	80,571	83,114	85,656	88,199	90,741	93,283

APPENDIX 16G. (*Continued*)

Kilometres	DAFGS el.	Model	1.5 h ($)	2 h ($)	2.5 h ($)	3 h ($)	3.5 h ($)	4 h ($)	4.5 h ($)	5 h ($)	5.5 h ($)	6 h ($)
Category 3												
50	Yes	PwC	55,727	58,270	60,812	63,355	65,897	68,440	70,982	73,525	76,067	78,610
		ITS	69,356	71,898	74,441	76,983	79,526	82,068	84,611	87,153	89,696	92,238
	No	PwC	55,492	58,035	60,576	63,119	65,661	68,204	70,747	73,290	75,832	78,374
		ITS	69,824	72,367	74,909	77,451	79,994	82,536	85,079	87,621	90,164	92,706
100	Yes	PwC	60,831	63,374	65,916	68,459	71,001	73,543	76,086	78,628	81,171	83,713
		ITS	73,977	76,519	79,062	81,604	84,147	86,689	89,232	91,774	94,317	96,859
	No	PwC	61,091	63,634	66,176	68,719	71,261	73,803	76,346	78,888	81,431	83,973
		ITS	74,913	77,456	79,999	82,541	85,084	87,626	90,169	92,711	95,254	97,796
150	Yes	PwC	65,935	68,477	71,020	73,562	76,105	78,647	81,190	83,732	86,275	88,817
		ITS	78,598	81,141	83,683	86,225	88,768	91,310	93,853	96,395	98,938	101,480
	No	PwC	66,690	69,232	71,775	74,317	76,860	79,402	81,945	84,487	87,029	89,572
		ITS	80,002	82,546	85,088	87,630	90,173	92,715	95,258	97,800	100,343	102,885
200	Yes	PwC	71,038	73,581	76,123	78,666	81,208	83,751	86,293	88,836	91,378	93,921
		ITS	83,219	85,762	88,304	90,847	93,389	95,932	98,474	101,017	103,559	106,102
	No	PwC	72,288	74,831	77,373	79,916	82,458	85,001	87,543	90,086	92,628	95,171
		ITS	85,092	87,635	90,177	92,720	95,262	97,805	100,347	102,890	105,432	107,975
250	Yes	PwC	76,142	78,685	81,227	83,770	86,312	88,855	91,397	93,940	96,482	99,025
		ITS	87,840	90,383	92,925	95,468	98,010	100,553	103,095	105,638	108,180	110,723
	No	PwC	77,887	80,430	82,972	85,515	88,057	90,600	93,142	95,685	98,227	100,770
		ITS	90,181	92,725	95,266	97,809	100,351	102,894	105,436	107,979	110,521	113,064
300	Yes	PwC	81,246	83,789	86,331	88,873	91,415	93,958	96,501	99,044	101,586	104,129
		ITS	92,462	95,004	97,574	100,089	102,631	105,174	107,716	110,259	112,801	115,344
	No	PwC	83,486	86,029	88,571	91,113	93,655	96,198	98,741	101,284	103,826	106,369
		ITS	95,271	97,814	100,384	102,899	105,441	107,984	110,526	113,069	115,611	118,154

Category 4												
50	Yes	PwC	67,683	70,225	72,768	75,310	77,853	80,395	82,938	85,480	88,023	90,565
		ITS	80,720	83,263	85,805	88,348	90,890	93,433	95,975	98,518	101,060	103,603
	No	PwC	67,511	70,053	72,596	75,138	77,681	80,223	82,766	85,308	87,851	90,393
		ITS	81,319	83,861	86,404	88,946	91,489	94,031	96,574	99,116	101,659	104,201
100	Yes	PwC	73,686	76,228	78,771	81,313	83,856	86,398	88,941	91,483	94,026	96,568
		ITS	85,815	88,358	90,900	93,442	95,985	98,527	101,070	103,612	106,155	108,697
	No	PwC	74,077	76,620	79,163	81,705	84,248	86,790	89,333	91,875	94,417	96,960
		ITS	87,012	89,555	92,097	94,639	97,182	99,724	102,267	104,809	107,352	109,894
150	Yes	PwC	79,689	82,231	84,774	87,316	89,859	92,401	94,944	97,486	100,029	102,571
		ITS	90,910	93,452	95,995	98,537	101,080	103,622	106,165	108,707	111,250	113,792
	No	PwC	80,644	83,187	85,729	88,271	90,814	93,356	95,899	98,441	100,984	103,526
		ITS	92,706	95,247	97,791	100,333	102,876	105,418	107,961	110,503	113,046	115,588
200	Yes	PwC	85,692	88,234	90,777	93,319	95,862	98,404	100,947	103,489	106,032	108,574
		ITS	96,005	98,547	101,090	103,632	106,174	108,717	111,259	113,802	116,344	118,887
	No	PwC	87,211	89,753	92,296	94,838	97,381	99,923	102,466	105,008	107,551	110,093
		ITS	98,399	100,942	103,484	106,026	108,568	111,111	113,653	116,196	118,738	121,281
250	Yes	PwC	91,695	94,237	96,780	99,322	101,865	104,407	106,950	109,492	112,035	114,577
		ITS	101,099	103,642	106,184	108,727	111,269	113,812	116,354	118,897	121,439	123,982
	No	PwC	93,777	96,320	98,863	101,405	103,948	106,490	109,033	111,575	114,117	116,660
		ITS	104,092	106,635	109,177	111,720	114,262	116,805	119,347	121,890	124,432	126,975
300	Yes	PwC	97,698	100,240	102,783	105,325	107,868	110,410	112,953	115,495	118,038	120,580
		ITS	106,194	108,737	111,279	113,822	116,364	118,906	121,449	123,991	126,534	129,076
	No	PwC	100,344	102,886	105,429	107,971	110,514	113,056	115,599	118,141	120,684	123,227
		ITS	109,786	112,328	114,871	117,414	119,956	122,497	125,041	127,583	130,125	132,667

APPENDIX 16H. COMMERCIAL CONTRACT KPIS 2001–2002(INDIVIDUAL OPERATOR NAMES HAVE BEEN SUPPRESSED)

Performance Measures 01–02	Metro Operators											
	A	B	C	D	E	F	G	H	I	J	K	Weighted Average
Age of fleet	9.93	10.06	11.26	10.14	14.91	15.13	NA	11.06	11.50	11.80	11.90	10.68
SSTS revenue/revenue	0.526	0.409	0.222	0.502	0.315	0.271	0.468	0.592	0.527	0.388	0.290	0.464
Revenue/costs	0.905	1.346	0.967	0.849	0.675	0.620	NA	1.178	0.882	0.691	0.820	0.881
Revenue ($)/total kilometre	$2.549	$2.978	$3.320	$2.649	$3.863	$3.529	$3.089	$3.230	$2.392	$2.753	$2.667	$2.763
Non-SSTS revenue ($)/non-SSTS passenger	$2.149	$5.282	$3.885	$2.739	$2.062	$3.303	NA	$7.622	$3.455	$2.974	$3.154	$3.038
Revenue ($)/passenger	$1.906	$2.695	$2.599	$2.729	$1.668	$2.287	NA	$3.050	$1.784	$2.086	$2.313	$2.491
Total costs ($)/passenger	$2.106	$2.001	$2.688	$3.213	$2.470	$3.691	NA	$2.590	$2.022	$3.020	$2.821	$2.828
Total costs ($)/non-STSS passenger	$5.012	$6.633	$5.162	$6.469	$4.458	$7.310	NA	$15.849	$8.272	$7.039	$5.419	$6.427
Total costs ($)/kilometre	$2.815	$2.212	$3.434	$3.118	$5.719	$5.696	NA	$2.743	$2.712	$3.986	$3.253	$3.102
Labour cost ($)/kilometre	$1.500	$1.099	$1.762	$1.593	$2.509	$2.315	$2.060	$1.580	$1.317	$1.878	$1.433	$1.609
Maintenance cost ($)/kilometre	$0.177	$0.081	$0.127	$0.168	$0.143	$0.220	$0.146	$0.192	$0.134	$0.111	$0.124	$0.154
Fuel cost ($)/kilometre	$0.364	$0.283	$0.308	$0.277	$0.386	$0.360	$0.361	$0.224	$0.228	$0.298	$0.304	$0.290
Overheads cost ($)/kilometre	$0.140	$0.136	$0.528	$0.206	$1.226	$1.153	NA	$0.206	$0.481	$0.540	$0.874	$0.288
Overheads cost/revenue	0.055	0.046	0.159	0.078	0.317	0.327	NA	0.064	0.201	0.196	0.328	0.105
Kapcost (ACC using insured value)($)/kilometre	$0.492	$0.612	$0.686	$0.257	$1.229	$1.577	NA	$0.503	$0.441	$0.687	$0.438	$0.397
Passenger/employee	50,143	43,292	42,073	28,203	60,024	42,877	NA	40,864	48,942	37,362	43,425	30,641
Passengers/kilometre	1.337	1.105	1.278	0.971	2.316	1.543	NA	1.059	1.341	1.320	1.153	1.097
Kilometre/vehicle	52,641	49,227	39,187	67,381	30,241	35,189	34,495	42,352	53,409	47,124	50,252	49,264
Kilometre/employee	37,506	39,173	32,933	29,059	25,920	27,781	26,177	38,582	36,489	28,307	37,657	30,634
Percent SL above MSL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Performance Measures 01–02	Country Operators						Total		
	L	M	N	O	P	Weighted Average	Unweighted Average	Weighted Average	Note: Average Weighted by Proportion of
Age of fleet	11.43	9.70	9.70	11.00	9.70	10.36	11.28	10.627	Total buses
SSTS revenue/revenue	0.774	0.948	0.845	0.870	0.688	0.772	0.540	0.502	Total revenue
Revenue/costs	0.887	0.606	1.458	1.435	1.132	1.185	0.963	0.912	Total costs
Revenue ($)/total kilometre	$3.476	$2.520	$2.885	$3.702	$3.170	$3.304	$3.048	$2.821	Total kilometre
Non-SSTS revenue ($)/non-SSTS passenger	$3.258	$2.505	$2.922	$8.324	$8.451	$6.430	$4.139	$3.120	Total non-SSTS Passenger
Revenue ($)/passenger	$2.467	$2.189	$1.839	$3.128	$3.492	$2.964	$2.415	$2.546	Passenger
Total costs ($)/passenger	$2.781	$3.615	$1.261	$2.180	$3.084	$2.502	$2.636	$2.790	Passenger
Total costs ($)/non-STSS passenger	$16.236	$79.328	$12.935	$44.733	$23.941	$23.784	$16.586	$6.847	Non-SSTS passenger
Total costs ($)/kilometre	$3.919	$4.161	$1.980	$2.580	$2.800	$2.789	$3.409	$3.066	Total kilometre
Labour cost ($)/kilometre	$2.035	$0.970	$0.877	$0.881	$1.233	$1.179	$1.565	$1.563	Total kilometre
Maintenance cost ($)/kilometre	$0.275	$0.272	$0.062	$0.088	$0.116	$0.122	$0.152	$0.150	Total kilometre
Fuel cost ($)/kilometre	$0.323	$0.206	$0.172	$0.182	$0.193	$0.202	$0.279	$0.281	Total kilometre
Overheads cost ($)/kilometre	$0.312	$0.298	$0.228	$0.605	$0.667	$0.557	$0.507	$0.318	Total kilometre
Overheads cost/revenue	0.090	0.118	0.079	0.164	0.210	0.168	0.162	0.114	Total revenue
Kapcost (ACC using insured value)($)/kilometre	$0.934	$0.994	$0.631	$0.789	$0.572	$0.683	$0.723	$0.429	Total kilometre
Passenger/employee	34,957	58,781	78,223	60,495	48,766	52,161	47,895	35,594	Proportion of employees
Passengers/kilometre	1.409	1.151	1.569	1.183	0.908	1.115	1.310	1.099	Total kilometre
Kilometre/vehicle	21,328	30,801	40,854	34,768	39,542	35,007	41,799	50,504	Proportion of vehicles
Kilometre/employee	24,811	51,060	49,841	51,118	53,717	46,785	36,883	31,793	Proportion of employees
Percent SL above MSL	NA	NA	NA	NA	NA	NA	NA	NA	NA

APPENDIX 16I. NON-COMMERCIAL CONTRACT SUMMARY KPIS, 2001–2002

Owing to the large number of non-commercial contract respondents, summaries by contract category only are included here. Accompanying the electronic version of this report is an excel file titled 'Non-commercial KPIs from survey final' which includes KPIs for each respondent.

2002 BCA Survey of Operators – Summary KPIs	Category One		Category Two		Category Three		Category Four	
	No GST	With GST	No GST	With GST	No GST	With GST	No GST	With GST
Revenue/costs	1.293	1.265	1.261	1.241	1.282	1.255	1.305	1.309
RevTNSW/cost	1.287	1.259	1.230	1.211	1.237	1.210	1.263	1.269
By contract kilometres								
RevTNSW/kilometre	$1.850	$1.850	$2.180	$2.180	$2.493	$2.493	$3.146	$3.146
Total costs/kilometre	$1.547	$1.583	$1.829	$1.862	$2.085	$2.131	$2.464	$2.516
Labour cost(except mechanic)/kilometre	$0.706	$0.706	$0.770	$0.770	$0.768	$0.768	$0.873	$0.873
Insurance and registration cost/kilometre	$0.101	$0.109	$0.122	$0.132	$0.116	$0.125	$0.141	$0.152
Repair and maintenance cost/kilometre	$0.107	$0.114	$0.178	$0.188	$0.219	$0.233	$0.219	$0.232
Fuel tyreC/kilometre	$0.164	$0.167	$0.183	$0.177	$0.215	$0.220	$0.268	$0.272
Fuel cost/kilometre includes DAFGS	$0.119	$0.131	$0.133	$0.136	$0.156	$0.171	$0.200	$0.220

Fuel cost/kilometre excludes DAFGS	$0.164	$0.181	$0.193	$0.200	$0.195	$0.215	$0.250	$0.275
Admin cost/kilometre	$0.293	$0.312	$0.242	$0.261	$0.247	$0.267	$0.300	$0.322
Other cost/kilometre	$0.005	$0.005	$0.010	$0.010	$0.029	$0.029	$0.030	$0.030
ACC of bus/kilometre	$0.170	$0.170	$0.323	$0.323	$0.490	$0.490	$0.634	$0.634
By actual kilometres								
RevTNSW/kilometre	$1.731	$1.731	$1.999	$1.999	$2.397	$2.397	$3.000	$3.000
Total costs/kilometre	$1.443	$1.477	$1.685	$1.715	$2.006	$2.051	$2.350	$2.399
Labour cost(except mechanic)/kilometre	$0.658	$0.658	$0.706	$0.706	$0.735	$0.735	$0.832	$0.832
Insurance and registration cost/ kilometre	$0.094	$0.102	$0.112	$0.121	$0.112	$0.121	$0.134	$0.144
Repair and maintenance cost/ kilometre	$0.102	$0.109	$0.169	$0.179	$0.212	$0.225	$0.212	$0.225
Fuel tyre cost/ kilometre	$0.156	$0.159	$0.167	$0.160	$0.205	$0.209	$0.256	$0.260
Fuel cost/kilometre includes DAFGS	$0.113	$0.124	$0.121	$0.123	$0.148	$0.163	$0.191	$0.210
Fuel cost/kilometre excludes DAFGS	$0.157	$0.173	$0.176	$0.182	$0.186	$0.204	$0.239	$0.263
Admin cost/kilometre	$0.270	$0.287	$0.223	$0.240	$0.238	$0.256	$0.286	$0.308
Other cost/kilometre	$0.005	$0.005	$0.010	$0.010	$0.027	$0.027	$0.029	$0.029
ACC of Bus/kilometre	$0.158	$0.158	$0.299	$0.299	$0.477	$0.477	$0.601	$0.601

This page intentionally left blank

CHAPTER 17

A BUS-BASED TRANSITWAY OR LIGHT RAIL? CONTINUING THE SAGA ON CHOICE VERSUS BLIND COMMITMENT

17.1. INTRODUCTION

In most cities, buses move more public transport passengers than any other public mode. Buses however operate mainly on mixed-mode infrastructure, competing with cars and trucks, a regime that has not, in general, favoured bus services. This has provided a strong argument in support of rail systems on dedicated right-of-way, free from the movement constraints of competing modes. The rail emphasis however has often come at a great expense (with non-commensurate benefits), especially in corridors where the traffic levels are quite low (Richmond, 1998; Mackett & Edwards, 1998), and door-to-door connection is a major influence on mode choice.

Over the last 20 years, we have seen the (re)introduction of trams (or light rail) as a suggested 'solution' to delivering public transport at a lower cost than heavy rail in the low-to-medium density trafficked corridors. Very few light rail systems have proven 'successful' on the criteria used to justify their construction and operation such as reducing car use (see below), raising fundamental questions about the viability of public transport in general and light rail in particular. The lessons to date reinforce the importance of delivering seamless transport services with good geographical coverage and sufficient flexibility to respond to changing market needs if we are to make a difference to the dominance of the automobile. The potential for dedicated bus-based infrastructure along major corridors with efficient interchanges and bus distribution deep into suburbia is recognised as having such potential, yet has been neglected internationally (with few exceptions such as Ottawa and Curitiba) relative to light rail. London Transport Buses in its Annual Review 1998 has recently renewed the call for the 'establishment of segregated busways' stating that "… it is now time to be more positive in taking road space from the private car".

Bus-based transitways are often compared with light rail and frequently criticised in favour of light rail on the grounds of their lack of permanence because of the opportunity to convert the right-of-way to a facility for cars and trucks (Smith & Hensher, 1998). Hensher and Waters (1994) and Richmond (1998) have put the case for bus-based transitways as a preferred option in most urban contexts where light rail has been evaluated. For many years the arguments for and against light rail and bus-based transitway systems have persisted, with light rail often the victor on ideological grounds. Unfortunately, light rail is increasingly the purveyor of substantial debt and operating subsidy (Mackett & Edwards, 1998; Richmond, 1998).

One very positive outcome of the ongoing light rail 'debate' is a recognition of the need to consider a larger set of public transport options than has traditionally been the case (including non-investment outcomes such as pricing and regulation) under a reasonable set of patronage assumptions. Notable comparative studies include Stone, Allen, Moerz, and Gardner (1992), Kain (1988, 1990), Biehler (1989), Nisar, Khan, and Johnson (1989), Richmond (1991, 1998), Pushkarev and Zupan (1980), Pickrell (1984, 1991, 1992), Smith and Hensher (1998), Mackett and Edwards (1998) and Taylor and Wright (1984).

The majority of bus-based schemes in most countries have generally been tried on a smaller scale than is necessary to give real advantages to buses (Stokes et al., 1991; Batz, 1986; Pettigrew & Angus, 1992; Richmond, 1998) and to compare them meaningfully with light rail. Typical lengths for transit lanes are usually not long enough to have a competitive effect with alternative public transport options or the automobile. It is not valid to compare the impact of short bus lanes with longer dedicated-way transit systems. However, there are some important examples of longer distance bus-based transitway operations in the USA, Canada, Brazil and Australia. The longer bus-based transitways such as the Shirley Highway into Washington, DC from Virginia is 19.2 km with two reversible priority lanes in the median. The San Bernardino bus-based transitway in California is 18 km (Gordon & Muretta, 1983) and the Route 55 HOV lane in Orange County is 20 km (Giuliano, Levine, & Teal, 1990). The 12 km Adelaide O-Bahn (or Northeast Busway) and the system in Rochefort (Belgium) are fully grade-separated from all other roads, and passenger interchanges are widely spaced, allowing running speeds of up to 100 km/h (Chapman, 1992). The M2 tollroad in Sydney has 16 km of dedicated busway with buses running at capacity patronage during the peaks. A series of express bus-based transitways covering 55 km are in place in Curitiba (Brazil) which occupy the median of each road, separated from slow-moving traffic lanes by pedestrian islands (Herbst, 1992). Ottawa, Canada has installed extensive dedicated bus-based transitways. The relevant comparisons between bus and LRT should focus on examples of these lengthy bus-based transitways.

We consider the evidence on the costs and benefits of light rail and bus-based transitway systems, with particular attention given to the biases in the positions taken by advocates of either form of public transport.

17.2. TAKING A CLOSER LOOK AT LIGHT RAIL AND BUS-BASED TRANSITWAYS

A Return to the Past or A Genuine advance in Technological-led improved Accessibility?

Yet another male politician, Alliance's list MP Grant Dillon, comes out in favour of light rail as the panacea to Auckland's transport problems, overlooking the fact that a lot of relatively cheaper bus lanes are failing to eventuate, due to cost. Buses are, therefore, neither as full nor frequent as they should be in a city of over 1 million people. I wonder if these men have ever given up playing with their Meccano sets? Jan O'Connor, Takapuna, letters to the editor, New Zealand Herald, March 7, 1997.

An increasing number of 'new' urban public transport systems are being developed in cities around the world, particularly light rail. The main objective of building such systems is to reduce car use, and so reduce road congestion and environmental damage. In many cases the systems are expected to stimulate development.

As a way of achieving these objectives what is the evidence that light rail rather than a bus-based transitway system or a less technologically driven 'solution' to improved public transport services is the way to go? The evidence consists primarily of two types: the costs of alternative systems and their effectiveness in attracting patronage (especially from car use). A third criterion, often implicit, is the impact on land-use and future travel patterns. This is alleged to be an important advantage of LRT systems.

Strong views exist on the merits of light rail as a preferred alternative to dedicated bus-based transitway systems. Why did many of these cities supporting and building light rail not consider having a very flexible bus system on the dedicated alignment which has the capability of offering much better door-to-door service than a very inflexible fixed rail system? The answers are relatively simple – the adage that "trains are sexy and buses are boring" (quoted from the Mayor of Los Angeles) says it all. I have previously described this as 'choice versus blind commitment' (Hensher & Waters, 1994).

When the evidence suggests that one can move three times as many people by dedicated bus-based transitway systems for the same cost or the same number of people for one-third of the cost as light rail, one wonders about the rationality of urban planning. For example, Wentworth (1997) concludes from a review of the proposal to extend the light rail system in Sydney between Central Railway and Circular Quay, that a re-designed bus system would provide a better immediate result at a greatly reduced cost. He asks:

> … perhaps the investors themselves may have been taken for a ride by professional promoters … Or is it just an innocent mistake? The only thing clear is that there is something fishy about the whole affair.

The NSW government has recently announced (1994) a bus-based transitway in preference to LRT for a 20-km transitway between Parramatta and Liverpool, two of the major regional centres in Sydney. The proposed Liverpool–Parramatta transitway (LPT) is an innovative development in the provision of infrastructure tailored to the specific needs of bus transport. Existing transitways (T2, T3 lanes) make a contribution, but they are limited in their ability to deliver sizeable benefits through time savings and seamless transport service to passengers and operating cost savings to bus operators. The LPT provides a real opportunity to deliver substantial benefits to operators and passengers. With appropriate planning and design, the opportunity exists to provide almost seamless door-to-door public transport services, with buses on the existing networks connecting into the LPT.

The LPT feasibility study compared light rail with a bus-based transitway and concluded that the bus system was significantly better in delivering higher levels of frequency (typically every 3 min compared to every 9 min for LRT) with lower incidence of transfers compared to using a feeder bus to connect to light rail. Since transfers are a major source of dissatisfaction, this is a crucial issue in attracting patronage. Although LRT costs per passenger kilometre are often argued to be lower than for bus systems, these comparisons are usually spurious because they are based on theoretical capacity and not on actual patronage. For LRT to provide an effective level of service it most likely has to operate at a frequency which does not maximise patronage on each trip. If this is the case, the advantage of light rail on operating costs per passenger kilometre is eroded. On construction costs, an integrated bus rapid transit system in Sydney can be expected to cost, at grade (in $M/km), based on the Brisbane Busways experience, from

\$0.1 M/km with shared use of existing road, \$1 M/km with widening of an existing road and \$1.5 M/km in an exclusive corridor. In contrast, LRT under the same three corridor contexts is respectively (on advice from GDH Transmark, March 1998), \$3.4 M/km, \$2.10 M/km and \$2.02 M/km.

The experience of Curitiba, Porto Allegre and Sao Paulo supports the contention that, under appropriate regulation, organisation and capital investment, bus-based transit systems are capable of transporting large volumes of passengers at reasonable speeds for minimal capital and operational costs. Table 17.1 illustrates this capacity by a comparison of the volumes achieved by bus-based transitways in these cities with a number of heavy rail corridors in the Sydney metropolitan region.

On the evidence, bus-based transitways function as efficient high-volume transport corridors where the operations are adapted from traditional bus practice and where substantial infrastructure investments are made in bus stops, terminals and vehicle types. Advantages of bus-based transitways over rail-based systems such as the avoidance of transfers at terminals and the use of standard equipment, may correlate negatively with the capacity the bus-based transitway can achieve. Certainly, the most successful high-volume bus-based transitways in Brazil require both passenger transfer and specialised equipment. On the other hand, where bus-based transitway systems are based merely on providing road space for operators to utilise (as in Porto Allegre), this results in low operating speeds and low productivity.

Although previous research has suggested that bus-based transitways on the Porto Allegre model could efficiently transport 39,000 passengers/hour (Cornwell & Cracknell, 1990), operating experience in Brazil does not

Table 17.1. Volume of Passengers Using Transport Corridors in the Peak Direction of Travel During the Peak Hour.

City	Mode	Line	Pax/h
Curitiba	Busway	Pinheirinho	11,000
Porto Allegre	Busway	Assis Brasil	20,000
Sao Paulo	Busway	Santo Amaro	25,000
Sydney	Heavy rail	Carlingford	400
Sydney	Heavy rail	Bankstown	5,700
Sydney	Heavy rail	Bondi Junction	6,200
Sydney	Heavy rail	Chatswood	11,900
Sydney	Heavy rail	Parramatta	14,800
Sydney	Heavy rail	Strathfield	28,000
Sydney	Bus lane	Military Road	6,700

Source: Smith and Hensher (1998).

confirm this figure. The current maximum volume carried on an efficient bus-based transitway (i.e., with an average speed greater than 20 km/h) is 11,000 pax/h in Curitiba, and where volumes exceed this, the average bus speed drops towards that of the surrounding traffic flow. It remains to be seen whether the Curitiba 'surface subway' and the proposed systems in Sao Paulo will be capable of both moving 22,000 pax/h volume and maintaining average speeds in excess of 25 km/h, as predicted.

Nevertheless, the existing bus-based transitways can provide an equivalent capacity to an LRV system, at a fraction of the capital costs. As Cornwell and Cracknell concluded:

> The capacity of a well designed and efficiently managed busway can be equivalent to that of an LRT, on a comparable basis (for example, degree of segregation; stop spacing). (Cornwell & Cracknell, 1990, p. 195)

and that

> … it should be noted that despite the current wave of LRT proposals, and the considerable resources which have been invested in various LRTs (Manila, Hong Kong, Rio de Janeiro, etc.), the consultants know of no LRT in a less-developed country which outperforms the busways surveyed in terms of productivity (passenger volumes × speeds). (Cornwell & Cracknell, 1990, p. 200)

In interpreting comparisons between LRV and bus-based transitway systems, it is important to note the contrast between 'theoretical' capacity and capacity achieved.

In summary, the evidence from a survey by Mackett and Edwards (1998) suggests that, in general, the impacts of light rail compared to bus-based systems are very limited in scale. The difference occurs because the evaluation framework that is often used as part of the development process usually ignores the latent (i.e., unsatisfied) demand for car use and so is liable to predict higher levels of patronage on the new system, and greater reductions in car use and consequential effects, than will be the case. Furthermore, the forecast patronage on the new systems often do not justify the construction of light rail (except where estimates have been inflated), but the planning and legislative framework under which schemes are developed (notably in Britain and the USA) militates against innovation and more cost-effective systems (Edwards & Mackett, 1996). This suggests that there is a need to adopt funding formulae that relate levels of local and non-local expenditure to the overall benefits more carefully. There is substantial evidence from the literature that expenditure on new rail-based schemes diverts resources away from bus routes used by the lower-income segment with no alternative mechanised mode of travel (e.g., Richmond, 1998).

17.3. MORE ON THE COST OF ALTERNATIVE SYSTEMS

Pickrell (1984) updated by Richmond (1998) compared actual bus system costs with best practice light rail costs, where buses are local services operating on congested roads. Pickrell uses Pushkarev and Zupan's concept of a rail/bus threshold, defined in terms of passenger miles per lane mile and peak hour passengers in the peak direction assuming an average trip length of 8 km, and bus operating speed of 12 mph. Pickrell shows that the bus/light rail breakeven point for little or no grade separation is 21,000 peak hour passengers in the peak direction, 37,000 with considerable light rail grade separation and 61,000 where grade separation is accompanied by a one-fifth tunnel. When buses are assumed to operate on exclusive or congestion-controlled right-of-ways, they are able to attain speeds equal to or higher than light rail (Kain, 1988) and hence the breakeven peak hour passengers will be much higher. Pushkarev and Zupan (1980, p. xiii), a much cited report by advocates of light rail, suggests in a comparison with high-performance bus systems, a breakeven for LRT of two to three times as high as the thresholds reported above, i.e., 42,000–180,000, depending on grade separation of light rail and level of service. The choice of base line bus alternative is extremely important in any comparison.

Comparing light rail with the average for buses is not very useful because it fails to compare the performance of equivalent types of service and fails to demonstrate the impact of implementing new rail service on total system financial performance. It is essential to compare rail performance to that of equivalent density bus services and to include the productivity of new feeder bus routes whose costs are 'caused' by light rail but which light rail management never includes with light rail costs in assessing the rail system's financial performance. The evidence suggests that bus services which are typical of those replaced by rail services have much higher productivity than bus systems in general (benefiting from economies of density); in contrast the new feeder bus services to support the rail network run at much higher costs and hence lower productivity than the bus system as a whole (derived from the Institute of Transport's International Benchmarking subscription programme for the bus and coach industry).

A comparison of the life cycle costs of providing bus services compared to light rail in Los Angeles (using the construction and budgeted operating costs of the LRT Blue Line) leads to a conclusion that for the same level of funding, Los Angeles can either afford to build and operate the Blue Line for 30 years or operate 430 buses for 33 years, including the cost of building the operating divisions to support these new buses. For the same cost, however, the buses would produce over four-and-one-half times as many passenger kilometres and carry over nine times as many passengers (Rubin, 1991). The decision to go with rail transit appears to have little economic or social basis. One can only surmise that there may be a physical planner's implicit assumption in the decision – that rail systems, unlike bus systems, can shape land use and that this alone is sufficient reason for justifying high levels of rail subsidy. As discussed in a later section, we find the 'evidence' that rail per se is more powerful than bus-based transitways in shaping land use is somewhat questionable. There are ways of combining any form of transport with incentives/disincentives through land-use legislation and/or pricing to achieve an outcome supportive of public transport.

Stone et al. (1992) compare a guideway bus priority system and light rail in an active rail corridor, under modal splits ranging from 0.5 to 50%. The LRT system operates on the existing rails with new bridges and track as needed for the dual guideway system. Thus, we have a situation of a relatively expensive bus priority system and a relatively inexpensive light rail system. The LRT system utilises the existing dual track structure and bridges in the first 12 km of the rail corridor, with new single track and bridges being built to complement the remaining 13 km of single track. The dual guideway (similar to O-Bahn in Adelaide) requires separate structures at all existing and new grade separations. Some additional cut and fill is necessary to build the parallel guideway. While both options have approximately the same travel time, the bus priority system costs 30% less than the LRT system. Stone et al. state that the high capacity of light rail cannot be exploited without future increases in transit demand (something which plagues all public transport), a feeder bus system, and land-use changes favouring higher ridership (an issue which is controversial, although see the Ottawa experience through regulation, discussed below). The inherent lower cost of the bus-based transitway reduces financial risk while its off-guideway flexibility automatically broadens service opportunities.

A study of public transport options in Canberra (Denis Johnstone & Associates, 1992) suggests that a bus-based transitway is more cost efficient than light rail. All operating and maintenance costs excluding depreciation and interest are \$3.00–\$3.50 per vehicle kilometre for a bus-based transitway and \$3–\$5 per vehicle kilometre for light rail, and capital costs are approximately 50% lower for a bus-based transitway. They argue however in support of light rail because it has the advantage of permanence due to its fixed track characteristic, the latter providing greater confidence for developers and other investors in ways which aid public transport use. The legislated procedures implemented in Ottawa and Curitiba however provide strong examples of how bus systems can also achieve such benefits, without relying on the argument of fixed track in order to secure the characteristic of permanence (Smith & Hensher, 1998).

The Canberra study indicates that there is no strong evidence that patronage would be significantly different for a bus-based transitway or light rail, throwing doubt on the reported operating costs per passenger kilometre (4.5 and 3 cents, respectively for conventional on-road bus and light rail), which assume higher loadings for light rail. The opportunities to achieve patronage levels in the ranges supportive of light rail are remote indeed. Any visitor to Canberra will notice the general absence of traffic congestion and existing bus services with unacceptably low passenger loads, throwing doubt on the wisdom of any major investment in light rail or a bus-based transitway, given Canberra's urban strategy. Seven years on, no decision has been taken on light rail although the popular view in planning circles in 1999 is that a bus-based system on *existing* roads makes eminently better sense, given the low patronage estimates.

Curitiba, in Brazil, introduced a bus priority system at a cost of $US54 million, 300 times less than a subway and also less expensive than light rail (Herbst, 1992). Curitiba's buses transport 1.3 million passengers per day, four times the number of subway passengers in Rio de Janeiro (a city of 10 million residents, more than six times the size of Curitiba).

Pittsburgh opted for exclusive bus-based transitways in preference for LRT. In a comprehensive review of the Pittsburgh experience contrasted with a number of LRT projects in Buffalo, Pittsburgh, Portland, Sacramento and San Diego, Biehler (1989) concludes that

> … busways offer an advantage over light rail for many applications due to their attractiveness to riders, cost-effectiveness, and flexibility. (Biehler, 1989, p. 90)

The South Busway, opened in 1977, is 6.4 km, primarily at grade with one section in a tunnel. The East Busway, opened in 1983, is 11.2 km entirely at grade except for a one-third kilometre elevated section. The LRT systems against which the bus-based transitways have been evaluated are still making adjustments to maximise patronage, in particular utilising the bus-feeder concept as part of an overall public transport system.

Although any comparison of systems located in different urban areas is problematic, nevertheless some amount of comparison is permissible in order to form a judgement on the relative merits of each system. As of 1987, the unit operating costs for each system are $0.43 for Pittsburgh East and

$0.56 for Pittsburgh South. These estimates compare with the LRT range of $0.85 (San Diego) to $1.50 (Pittsburgh). We recognise the inadequacy of such a measure of effectiveness, despite the striking differences in costs.

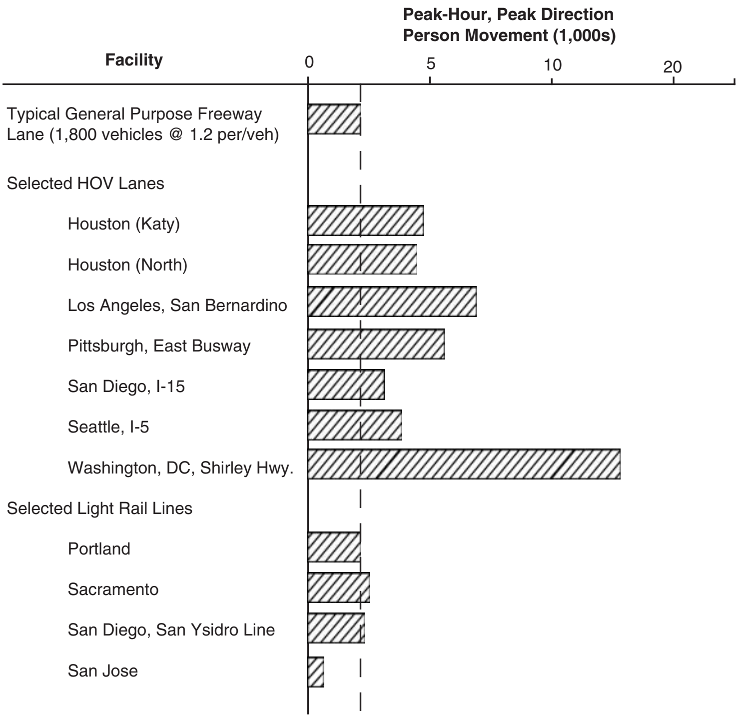
The most telling evidence is provided by Kain and Liu (1995), who compare the operating and capital costs of San Diego light rail with an equivalent bus system. Most comparisons between systems (especially in the USA) use operating costs per boarding as their performance indicator, in contrast to a total cost per boarding, the latter including capital costs. Kain and Liu (1995) conclude that San Diego's LRT operating cost per trip is substantially lower than any of the bus operators. In contrast, the San Diego bus transit system has the lowest fully allocated capital and operating cost per boarding by a significant margin.

Table 17.2 shows that LRT systems are not moving any more people per hour during the peak than could be handled by one lane of a freeway. In contrast, bus and HOV lanes do move more people than would a freeway or an LRT with modest ridership. The HOV lanes look particularly good since they achieve higher utilisation of the facility than one restricted to transit vehicles only. But note that even bus-only lanes (e.g., Houston, Pittsburgh) outperform the LRT lines listed. The important implications of this comparison in Table 17.2 are: (i) the bus-based transitways are shorter in length than the LRT lines, (ii) they carry about the same number of passengers per day (at higher rates of ridership because of shorter length), and (iii) they cost about the same per kilometre to construct as the *lower* cost LRT systems (Table 17.3).

17.4. MORE ON PATRONAGE?

An obvious consideration in any debate on modal futures is the capability of a mode to attract patronage. The previous sections noted several examples showing that bus systems can service more passengers per dollar than LRT systems. Much of the literature on LRT ignores the demand side of the picture, concentrating on issues of costs and technology. Presumably, the basic purpose of urban passenger transport is to provide the technological basis for mobility in order to give people the accessibility they require. It is not to transport subsidised fresh air. It is somehow assumed in most commentaries on LRT that there is a sufficiently strong demand to justify a (subsidised) public transport service, and that the consequences on the environment are net positive. Indeed official projections of light rail system ridership have erred substantially on the high side. For example, the actual

Table 17.2. A Comparison of Ridership Rates of a Number of USA Bus-based Transitway Systems and LRT Systems (the LRT Systems Selected Are Regarded as the Most 'Successful', Especially San Diego).



ridership on the Portland LRT (cited by Newman and Kenworthy (1989) as an example of best practice) was only 45% of the official forecast (Gordon & Wilson, 1985).

In the United States, there have been many instances of massive over-forecasting of the impacts of new rail systems. It has been suggested that local politicians and planners are so keen to obtain a new light rail or metro system that their enthusiasm has outweighed their judgement (Richmond, 1998).

The Portland–Oregon light rail line diverted 6,500 daily trips from the automobile out of a total of nearly 4 million daily trips (Hensher, 1992a). This is equivalent to less than 50 days of natural travel growth in total

Table 17.3. CMTC Busways in Sao Paulo – 1994.

	Paes de Barros	Santo Amaro Avenue 9 de Julho	Vila Nova Cachoeinha
Year of opening	1980	1987	1991
Type of bus	Trolley	Trolley and diesel	Diesel
Length	3.4 km	14.6 km[a]	11.0 km[b]
Terminals	1	1	2
Overtaking lanes	No	Yes	No
Busway Rtes[c]	6	27	14
Number of buses	61	372	159
Buses/peak hour	30	250[d]	75
Pax capacity/h	3,000	25,000	8,250
Peak hour operating speed	N/A	AM: 21.0 km/h PM: 11.2 km/h	AM: 23.0 km/h PM: 16.0 km/h

Sources: SMT (1993a, 1993b).
[a]Of the 14.6 km, only 11.0 km is exclusive bus roadway.
[b]Of the 11.0 km, only 5.5 km is exclusive bus roadway.
[c]Includes both trunk routes (using the corridor) and associated feeder routes.
[d]In addition, up to 50 illegal buses use this corridor per hour.

person trips over the last 10 years in the metropolitan area. In Los Angeles, the number of new rail transit trips since the entire Blue Line opened is 21,000 out of 38 million daily trips (with 63% diverted from bus). The days gained from the Blue Line in Los Angeles are estimated as equivalent to fewer than 5 days of natural travel growth over the last 10 years. The implication is that the entire proposed light rail investment of nearly $US2 billion in Portland and $US6 billion in Los Angeles might ‘buy’ a year’s growth (Cox, 1991).

The overriding evidence suggests that up to 70% of new rail patronage is diverted from bus (an experience reproduced in Sydney and Perth), with buses re-routed to serve rail interchanges. The Blue Line in Los Angeles is indicative of one such outcome. The Blue Line has a taxpayer cost of $US21 per rider per day. Since few of its riders are former drivers (as opposed to bus users), the system costs taxpayers $US37,489 per year for every car it currently removes from the freeways. A comparison of the life cycle costs of providing bus services compared to light rail in Los Angeles (using the construction and budgeted operating costs of the LRT Blue Line) leads to a conclusion that for the same level of funding, Los Angeles could have either afforded to build and operate the Blue Line for 30 years or operate 430 buses for 33 years, including the cost of building the operating divisions to support these new buses. For the same cost, however, the buses would produce over four-and-one-half times as many passenger kilometres and carry over nine times as many passengers (Rubin, 1991). This result is reached even though the assumptions made tended to favour the Blue Line on several important issues.

The northern suburbs transit system (NSTS) in Perth, West Australia, which opened in 1992, attracted both previous car and bus users, with 64% of its patronage coming from bus. When the impact of road traffic is calculated, we find that the vehicle volumes per week day have dropped by less than 2,800 vehicles out of a total of 100,000, or 2.8% (Luk, Rosalion, Brindle, & Chapman, 1998). This is very small indeed and raises questions about the value of an expensive heavy rail system, which impacts significantly on a bus system and little on car demand. A dedicated bus-based transitway on the existing expressway may have been a better proposition? The Gold Coast railway in Queensland is another example of a failed effort to attract drivers out of their car – its primary source of patronage is ex-bus travellers. Is this really the way to redress the imbalance?

Sydney has also embraced the *old idea* of inflexible public transport with the return to its streets of a steel-on-steel light rail system between Ultimo and Pyrmont in southern central Sydney. We are now seeing the mingling of trams with cars and buses as the street system struggles to cope with another form of old public transport which competes with walking and buses far more than it has attracted individuals out of their cars. Even with high parking prices in and near the Central City of $8 per day on average (see Hensher & King, 2001), this increased accessibility offered by more public transport technology has done little more than provide an interesting tourist attraction and satisfy the needs of those who believe in trains as the only form of public transport.

The new Sydney Star City Casino is expected to be a major traffic generator. Indeed, so important was the Casino in early discussions with Government that a risk provision in the privatisation contract stated that "If the permanent Casino opens for trading more than 12 months after the light-rail is completed, or after 31 March 1998 if this is a later date, the Department of Transport will be liable to pay the Pyrmont Light Rail Company $8,219 per day until the Casino opens". This says a lot about patronage risk from other sources. As of late February 1999, the patronage levels are well below forecasts with a peak in the very early hours of the morning as casino staff return home. Mees (1998) undertook a survey of Sydney light rail passengers in mid-1998 to investigate the sources of patronage and found that the main passenger groups are tourists and Star City employees. She also found that "… light rail in Sydney has limited impact on reducing car use, and the majority of passengers are attracted from pedestrian or other public transport services, hence is directly competing with other sustainable modes" (p. 13).

A cost–benefit comparison of LRT and an exclusive bus-based transitway applicable to Sydney (Ip, 1992) under peak loads varying from 1,500 to 4,500 pcu/h and total daily one-way flow from 15,000 to 70,000 pcu, produced benefit–cost ratios varying from 0.94 to 5.43 for LRT and 1.09 to 7.32 for a bus-based transitway. In all cases, the bus-based transitway had a benefit–cost ratio significantly higher than LRT, even allowing for a 25% higher level of patronage using the LRT than the bus-based transitway system. The usefulness of these figures however is critically dependent on patronage assumptions.

Limited consideration is given in the literature to incentives required to get people out of their cars and to increase rail use to a level that does not require massive subsidy. There is a strong presumption that the argued merits of rail systems such as environmentally friendly high capacity with typically low fares will provide the necessary incentives. Despite the best of intentions, the failure in the last 20 years to attract significant levels of new patronage to rail is in large measure due to the lack of disincentive to using the car (Hensher, 1998a).

A common conclusion from many investigations of new light or heavy rail in the major western capitals with densities typical of USA and Australian cities *and* inefficient prices is that rail systems cannot attract sufficient patronage to justify them:

> Unfortunately, the more we learned about the cost and ridership of this proposal, the more convinced we became that it does not deserve legislative or public support. Our opposition is dominated by one simple, general conclusion – Metropolitan Council and Regional Transit Board projections establish clearly that LRT would attract so few people from driver-only cars that it could not *significantly* increase transit ridership. (Citizen's League, 1991)

Richmond's (1998) update for the USA and Canada reinforces and extends the conclusions of Pickrell (1984). In the words of Richmond:

> Optimistics claims that new urban rail systems would increase transit patronage, reduce congestion, and improve the environment while at the same time improving the financial performance of transit systems have proved incorrect in most instances. … The evidence shows that the capital funds spent have generated few benefits. (p. 39)

One of the most disturbing features of the rail bias is the damage it has done to bus operations.

> While rail's contribution to increasing transit ridership … has been mostly minimal, changes in bus operating practices designed to accommodate rail have generally had a negative effect on the financial productivity of the transit systems concerned. (p. 39)

A growing concern in any comparisons between bus-based transitways and light rail is the quality of the data on patronage. In the USA, most data are unlinked trips (or boardings) and not complete journeys (i.e., linked trips). This means that a previous bus traveller who may have had a single bus trip but now is forced through loss of service to use the new bus to rail station and rail alternative is actually recorded as two unlinked trips. Such reporting has tended to inflate the true amount of travel by public transport. It is ironical that a degradation of service levels creates an increase in the number of unlinked trips, which are used by proponents of light (and heavy rail) to promote the virtues of rail as an attractor of increased patronage.

Indeed when linked trips data are used, there usually is a noticeable loss in patronage to public transport due to the diminution of service levels through being forced to change modes consequent on a loss of the cross-regional bus services. Rail ridership in the USA and UK has been encouraged by the simple expedient of taking alternatives away. The general pattern has been to discontinue through bus services and instead terminate them at suburban light rail stations. The number of passengers attracted to rail who are 'new' to transit are in most cases insubstantial. The Denver experience is an excellent example of this outcome:

> In no case has new rail been shown to have a noticeable impact upon highway congestion or air quality; although the Denver light rail system has satisfied the objective of removing from center-city streets buses diverted to terminate at light rail stations. (Richmond, 1998, p. 40)

Gross ridership figures for light rail in places such as San Diego and Portland may seem impressive. However, a total systems perspective shows that the total impact on public transport patronage is not only slight but that equal or better results can be obtained from relatively minor adjustments of fare levels and low-cost improvements to existing bus services. The West Australian heavy rail, and the Gold Coast and Sydney Light rail investments are very good examples of this outcome. Hardly something to be proud of and giving great civic pride. A common comment in Sydney is how few people seem to be using the light rail system – many almost empty carriages parading the streets of Sydney promoting the virtues of transporting fresh air!

The argument that light rail (in contrast to bus-based transitways) is needed to catalyse changes in travel patterns is very questionable. While it is the case that the Blue (South) Line in San Diego is a very successful project in providing the rallying point for transit development (and its financial performance is impressive), it is the exception than the rule. It is however well behind the Ottawa bus-based transitway on financial performance. However, Pittsburgh's busway system, like Ottawa and Curitiba in particular, provides impressive counterarguments to the claim that light rail is needed to catalyse changes in travel patterns. Originally built with the idea of using a bus-based transitway as a transition plan towards light rail (like so many of the proposals), its success has resulted in management losing interest in light rail and pursuing further development of the bus system. Ottawa, Pittsburgh and Miami all contradict the notion that buses cannot provide the capacity of light rail. As Richmond says "… The moral is that high-performance but less glamorous projects can gain local acceptability once success has been demonstrated" (Richmond, 1998, p. 44).

One wonders why we are investing such large sums into rail systems when the returns are so poor and expensive per additional passenger trip, and the success in attracting people out of their cars is so miniscule. The same arguments, but for lower cost, may well apply to bus-based transitway systems but the financial risk is considerably less.

17.5. IMPACTS OF PUBLIC TRANSPORT FACILITIES ON LAND USE

All forms of transport infrastructure have some impact on land use, be it freeways or public transport. The real issue is to what extent there is a linkage between the provision of particular types of public transport and land use. In particular, does LRT have land-use impacts that are different from bus-based transitways, and is the difference substantial and desirable?

Using property values as a surrogate for land-development impacts, not an unreasonable assumption, a survey of 2,500 properties in San Diego concluded that property values are determined by factors other than LRT (Urban Transportation Monitor, 21 August 1992). The study compared similarly developed properties adjacent to the transit facilities, properties that were outside the influence of LRT, and properties that were operating prior to the advent of LRT. There was no impact on residential properties, with most commercial uses having no impact, except for one motel and one small retail centre near a station that showed a 25% increase in lease rates attributed to LRT. Access overall was a far more important consideration.

> Our conclusion from the limited evidence is that any transport infrastructure investment will have a significant impact on land use where it contributes in a non-marginal way to accessibility, regardless of its nature.

The M4, a tolled motorway in Sydney, e.g., is already having an impact on land use in the western areas of Sydney resulting in increased median land values. Washington, DC Metrorail which has a 26% modal share for downtown travel has impacted on land use around stations and contributed to property values in some locations, although other factors have in general dominated the shape of land use – in particular the quality of the location overall. A recent inquiry by Brindle (1992) into the Toronto experience (a city extensively cited by Newman and Kenworthy (1989, 1999) as an example of how rail systems encouraged re-urbanisation), concluded that:

> the experts interviewed in Toronto were hesitant to claim 'proof' of a close relationship between transit and land development, or that the transit-supported centres … had so far produced significant improvements in travel efficiency and lifestyle. (Brindle, 1992, p. 23)

When one reviews the evidence on the role of public transport in stimulating particular land uses, the overriding feature for development-stimulus is the permanence and volume of public transport system increases. This is the claimed basis for preferring LRT over bus systems. Although buses take people to where activities are and follow the movement of activities over a wide geographic pattern (Paaswell & Berechman, 1982), in contrast, some argue that rail systems have a more active land-use/transport relationship because of their perceived permanency.

The begging question is: what makes for permanence? One of the arguments frequently propounded by supporters of LRT is that it cannot be taken away, whereas a bus system can, although we cannot find any cities where this has actually occurred. The cost of producing flexible service capable of potentially responding to changing geographic activity patterns is the price of reduced commitment to the facility. There is greater truth in this statement where dedicated bus-based transitway infrastructure is not in place, especially infrastructure built specifically for exclusive bus use. Ottawa's busway system combined with strong land-use regulatory powers illustrates what can be done for bus-based transitways to have a significant impact on land use. The system operates just like any other rail system with vehicles stopping at each 'station'. Ramp access is provided for express and limited stop routes so that a direct no-transfer service is provided between the residential and major trip generator locations. High rise in Ottawa–Carleton is already occurring at some stations and an integrated shopping centre/transitway station has recently been opened. Over \$US700 m in new construction is underway around transitway stations (Henry, 1989).

Ottawa's legislatively mandated land-use and transportation plan gives precedence to public transit over all forms of road construction or road widenings, with planning regulations requiring developers to concentrate developments near transit, to orient buildings and private access to transit stops, to provide walkways and transit-only roadways through developments, and to enter into agreements with the municipality on matters such as staging construction to accommodate transit.

The message from Ottawa and Curitiba is that a metropolitan strategy can embed an effective bus-based system within its overall land-use/transport plan that can produce the same types of impacts as rail. Based on the Ottawa and Curitiba experience, what is required is enabling legislation with a mandated land-use/transport plan that explicitly prioritises the role of bus-based systems. If we look at the recent experience in Perth (Western Australia), the only noticeable development impacts after nearly a decade of electrification and six years of the new northern suburbs rail system, occurred where a government development agency has taken the running in East Perth, Subiaco and Joondalup1.

The arguments in favour of rail systems are mainly premised on the absence of such legislation. It may be that bus-based systems require much more directed assistance via legislation than does a rail system in order to have an impact on land use. Of course, contradictory legislation and zoning could thwart rail impacts on land use. The implication is that appropriate zoning and possible legislation should be an integral part of transport and land-use strategies. If this co-ordination is done, bus systems are all the more attractive because they are considerably less expensive for a given amount of returned benefit and more flexible in responding to change. It may be that the bus-based system must be seen as having the essential characteristic claimed by rail – permanence and dedication. The value of HOV lanes with multiple-occupant automobiles must be weighed against this perception of 'rail characteristicity' if bus systems are to act as catalysts for land-use planning as well as providing a high level of service.

The Ottawa transitway (or bus-based transitway) is unlike a bus lane in that it provides (i) rapid service between 'stations' (similar to a rail rapid service); (ii) direct express services via transitway providing the local feeder as well as the linehaul service without transfer; (iii) general urban areawide transit service that uses the transitway for a part of the overall route and thus enhances not only its average overall speed, but also the frequency of service between some stations on the transitway; and (iv) local service to stations provided by feeders.

In designing a bus-based priority system which has an effective collection and distribution capability deep into suburbia, the density of passenger movement through bus-based transitway stations as well as fewer stations (compared to rail) might act to reduce the attraction of land-use development at and/or near the bus stations in contrast to the LRT stations. Nevertheless, the appreciation of land values and the agglomeration of activity close to stations should not be seen as of higher priority in an overall metropolitan strategy, in contrast to improving mobility and accessibility. A mix of objectives is necessary.

Ottawa may well have got it right (Henry, 1989; Nisar et al., 1989). Transportation service provision should foremost cater for the dispersed travel needs of the population as well as recognising the desirability of agglomeration economies spread throughout the metropolitan area, aided significantly by legislative reform. There is scope in the longer term to encourage the decentralisation of activities (which is happening anyway) and hence reduce the reliance on the central core of urban areas, and hence reduce average trip lengths (Hensher, 1993a, 1998a).

Curitiba, a city of 1.6 million located 400 km south west of Sao Paulo, implemented a master plan in the late 1960s, which restricted high-density growth to several slender corridors radiating from the city centre. The traditional core has given way to a cluster of high rises and scattered outlying development with all tall buildings arrayed along five transportation axes. Express bus-based transitways occupy the median of each road. To achieve this, the city brought or condemned a substantial amount of land along or close to the transportation axes and enacted zoning regulations that restricted high-density development to a two- to four-block corridor on both sides of the road. Flower street, an auto-free downtown pedestrian zone was created, banishing cars in a 17-block area.

The Brazilian experience supports the key interrelationships that exist between successful bus-based transitway operation and long-term planning, land use, appropriate regulation and political stability. Where bus-based transitways have been implemented in isolation from coherent planning and land-use strategies, the results have been either partial, inefficient systems (as in Sao Paulo) or overcrowded systems, which cannot adequately meet demand (Porto Allegre and Sao Paulo). The outstanding feature of Curitiba is that an integrated system of bus service types has developed in response to a clear and structured urban plan. This combination of a planning-driven 'bus-friendly' urban form and a marketing-driven, innovative bus operation has provided Curitiba with an excellent transport system. The bus-based transitways are no more than an important element in this process.

Furthermore, the contrast between Curitiba and Sao Paulo is not so much in the preparation of plans, but in their consistent implementation over a 30-year time frame. Political stability has enabled the planning and innovation in Curitiba to deliver results. Similarly, the effective use of bus-based transitways is also dependent on an integrated regulatory regime. The decline in the effectiveness of the Porto Allegre busways results from the removal of the 'umbrella' regulation of EBTU. Although the multiple operators have effectively developed a system-wide fare system, they have not been able to maintain the efficiencies of the bus-based transitways. Similarly, a major restraint on the Santo Amaro bus-based transitway in Sao Paulo is the presence of 'pirate' bus operators, who overload the capacity. An efficient bus-based transitway requires a firm and coherent system of regulation.

The bus-based transitway systems in Curitiba, Porto Allegre and Sao Paulo provide an illustration of the strengths and weaknesses of this transport mode. Although these systems have operating weaknesses, and although many aspects of their operation are not transferable to other national contexts, they nevertheless provide working examples of the capacity of the bus to provide cheap and efficient solutions to major urban transport problems.

The Ottawa and Curitiba experiences are worthy of special investigation. They appear currently to offer the best examples of how a bus-based system can be a major alternative to light rail in terms of the wider range of criteria used to justify a rail-based public transport system. It is easy to be critical about the strong-arm approaches to legislated zoning (some supporters of LRT suggest that zoning legislation is not required to achieve these types of land-use reforms), but it did achieve the objective using a more cost-efficient form of public transport. The success of legislative regulation depends very much on a commitment. The USA experience in legislative reform in order to achieve efficient and effective reform of public transport favouring bus and LRT systems has not met with success as well summarised by Henry (1989):

> While such formidable land use controls [as in Ottawa] may be envied by many U.S. planners, it is most unlikely that the massive legal, political, and other obstacles to their implementation in U.S. cities could be overcome. (Henry, 1989, p. 177)

It is encouraging however to note the success of Pittsburgh, who succeeded in introducing a bus-based transitway system in contrast to light rail without the imposition of legislative zoning. Markets can be and often are stronger instruments in achieving outcomes if properly managed.

17.6. AN ASSESSMENT OF CURRENT EXPERIENCE

This section brings together various points gleaned from the reviews of current experience and the arguments in the bus transitway – LRT debate. The main point is that the enthusiasm (almost blind commitment) for LRT has caused many to overlook the potential for more cost-effective bus-based systems and even simpler improvements to bus services that do not require dedicated right-of-way.

1. Bus-based transitway systems can be shorter in length than LRT because the routes that use them can fan out into residential and commercial areas for closer collection and distribution. Transfers and transfer time are reduced. LRT can have feeder buses but with added time delay (and often higher unit operating and capital costs than an integrated bus system), although the disutility of a bus–rail transfer penalty is lower than for a bus–bus transfer. This provides some basis for promoting the design of bus-based transitways in the context of the entire collection and distribution task, ensuring that the exclusive bus-based transitway combines with the entire matrix task of buses to minimise transfers, as successfully executed in Curitiba (Herbst, 1992), Ottawa and Pittsburgh.
2. We know that transfers are a major constraint on the use of public transport (Horowitz & Zlosel, 1981; Charles River Associates, 1989; Richmond, 1998). The act of changing buses or between bus and LRT produces a large penalty that is independent of the amount of time involved in transferring. This suggests that long-term strategies should include the provision of a better mix of more direct but less-frequent bus routes and more frequent services, adding branches and opening loops. Public transport networks that are planned to minimise travellers' disutility, *including transfer penalties* (i.e., not just time but the act of transfer) will look substantially different from those planned to minimise overall travel time. LRT appears to work against this objective.

A three-tiered bus system, arguably one of the most efficient in the world, was introduced in Curitiba which allows passengers to transfer without charge from the red express services along the axes to the yellow feeder services that circulate through outlying districts and bring passengers to transfer stations, and to the green interdistrict buses that travel in concentric circles to connect outlying areas. A computerised traffic control system gives priority to buses. There are 100 tubular bus shelters, with passengers paying fares at a turnstile at the end of a clear tube and then waiting inside, entering the bus from sliding doors in the tube. Boarding and alighting are considerably speeded up.

1. The total operating costs per passenger of LRT are typically higher than the typical bus-based transitway, where comparisons are possible. The most cost-effective LRT is 60–80% higher on unit operating costs than a bus-based transitway. The comparison must be qualified by the fact that LRT trip lengths are longer, although the bus-based transitway component of the bus trip only is typically used in the comparison. When the fully integrated bus–LRT or bus–bus systems are compared on unit operating and capital costs, the latter is even more attractive financially. The level of patronage will be critical to the outcome.
2. Bus-based transitway systems are simpler to operate and maintain than LRT systems, the latter typically attracting a sizeable support system such as an operations control centre and maintenance facilities. The interrelations between communication, signal power and propulsion systems for LRT is more likely to contribute to complexity and bureaucracy which is significantly less (but not absent) for bus-based transitways.
3. We seem to have accepted the division between the ownership of the infrastructure for bus provision and the operation of the buses. We are struggling with this dichotomy for rail-based systems. The issue of subsidy cannot be ignored in both systems. If we draw on the property rights argument, there is a very clear case for allowing any bus operator to access the bus priority infrastructure; and hence a case for having the infrastructure owned by a non-local bus operator. Although this division can also apply for rail, it is more likely to gain acceptance for bus systems because of the perception of a more 'natural' division than for rail. Indeed access by non-bus vehicles to share the infrastructure to maximise the use of the excess capacity in the off-peak in particular is a more attractive proposition than LRT. The NSW government is struggling with this dichotomy at present with the Liverpool–Parramatta bus-based transitway.
4. Bus-based transitway systems permit far more flexible operation (Moffat, 1991). Buses travelling in one direction can pass more easily than LRT, especially when off-line bus-based transitway stations are used. Fouracre and Gardner (1992) note that the provision of overtaking facilities at bus stops is found to be a particularly effective way to increase throughput (up to a theoretical estimate of 30,000 passengers per hour in one direction) and to decrease journey times, particularly when limited stop or

express services are operated. As bus use builds up the opportunity for bus chaining (especially as a guideway technology) becomes feasible.

5. Although it is argued that LRT operates at a greater theoretical capacity than a bus-based transitway, this has been questioned under closer assessment (Goodwin, Hallett, Kenny, & Stokes, 1991). Biehler (1989) claims that the capacity of light rail is about 200 passengers per vehicle times 40 vehicles per hour (90 s headway) or 8,000 passengers per hour. Articulated buses operating at 60 s headway yield 6,000 passengers per hour, assuming 100 passengers per bus. One must be conscious of the possibility of requiring a transfer where the patronage demand on a 'feeder' service is not sufficiently high to justify articulated buses. It can be argued however that the elimination of transfers will increase patronage and hence is a strong case for articulated buses in the collection, linehaul (bus-based transitway) and distribution stages.
6. The critical consideration here must be the success that each mode can have in attracting patronage. Time and time again we come back to the nature and success of marketing strategies in promoting the various forms of public transport *and* the importance of redressing the pricing and other distortions, which encourage the car. Critical issues will always centre on the factors that influence the choice between car and public transport.
7. Although LRT can be entrained creating multiples of base capacity per hour, bus-based transitway capacity can be greatly enhanced by multiple buses using a single off-line station as well as through-buses which can pass very easily (as can LRT but at quite an expense for additional track). The bus-based transitway can also serve as the guideway for local bus services that have collected patronage locally and then become express non-stop to the central business district or a regional centre.

On a number of reasonable assumptions the patronage potential for a bus-based transitway can be as high as twice that of LRT. The relativities will be determined by the sophistication of the design of the bus-based transitway system. Establishing actual patronage is another issue, although we have yet to find any unambiguous evidence to suggest that you can attract more people to LRT than a bus-based scheme. This arises because of *the difficulty of finding very similar circumstances in which both LRT and a geographically comparable bus-based system are in place*. Certainly, the performance of the dedicated bus-based transitway systems in Curitiba, Pittsburgh and Ottawa deserve closer scrutiny.

17.7. CONCLUSIONS

There is a lot of support for an attractive alternative to the car in cities. However, it is very important if public transport is the way ahead that the investment in such systems is made in a rational way. There is a need for less-expensive technology and consideration of more appropriate ways of addressing the problems caused by the automobile. Although there are signs of a shift from light rail to bus-based systems, following on from the earlier shift from metro to light rail (Edwards & Mackett, 1996), there are still many examples of more sophisticated technology being used than is necessary.

These all suggest that there are three major issues to be addressed: firstly, how to counter arguments about the very expensive 'image benefits' bestowed by a brand new light rail system that a bus cannot provide; secondly, how to amend the funding mechanism so that the maximum benefit is obtained from the investment of public money in urban transport; and thirdly, how to amend the analytical process so that it does not over-estimate the benefits of a new public transport system.

The first two issues are related. The usual procedure is for local planners and politicians to promote and design a scheme, and then to apply to the appropriate government for the funding. It is easier to make the case for a 'high-tech' discrete rail-based system rather than upgrading an existing bus system.

The USA transit experience is clouded by the availability of cheap money and the absence of any effort to provide incentives to attract patronage. Much of the debate in the 1990s on new rail systems in the USA has emanated from over-zealous forecasts of patronage at the time of seeking financial support from Capital Hill. These projects failed to recognise how difficult it is to get people out of their cars:

> The impetus for building rail systems in the US has little if anything to do with passenger demand. It is largely related to the availability of federal money to build such rail systems. (Cox, 1991)

> Those responsible for transportation planning seemed more concerned about raising and spending vast sums of money than with improving mobility or improving transit service and increasing ridership. (Kain, 1988, p. 198)

The quote from John Kain sensitises us to the growing emphasis on opportunities for raising and spending large sums of money on nicely visible infrastructure such as light rail systems which are 'permanent' in ways which appeal to civic pride, to owners of strategically located property investments, and to politicians who see an opportunity for historical associations with physical monuments. Newman and Kenworthy (1989, p. 28) put forth the view that good rail transit systems provide the opportunity for highlighting public values in ways which give a city new pride and hope for the future. While this may have some truth, it should not deny the capability of achieving the same impact with a high-quality dedicated bus-based transitway. The images created in promotion of the proposed LPT in Sydney actually are more appealing to civic pride than the existing heavy and light rail systems.

What is needed is a funding regime that permits the development of maximum accessibility for a given sum. In many cities, $200 million spent on a bus system would produce more improvement in accessibility than the same amount spent on a single light rail line, because the former system would cover a much larger area and so serve more people. However, it would not be so glamorous, and so the politicians and planners might not be so willing to plan and promote it. Nor would it be so easy to finance under present funding regimes that are geared to individual projects rather than achieving maximum benefits. In fact, in Britain outside London, because of bus deregulation it would be almost impossible to develop a large comprehensive bus-based system. Thus, there has been the irony of a national government, which was committed to reducing public expenditure, funding expensive light-rail schemes because its desire to introduce market forces to bus operations meant that local bus services could not be planned and coordinated (Mackett & Edwards, 1996a, 1996b, 1998). All large cities in Britain either have or are developing new light rail systems. It is likely that light rail is not appropriate for smaller cities, but bus-based systems cannot be used in the UK for the reasons cited above. Some smaller cities are considering bus-based transitways and kerb-guided buses, but none are near to implementation. The existing kerb-guided bus system in Leeds and a similar system in Ipswich are very modest.

What about the future for bus systems? Buses, especially bus-based transitway systems are arguably better value for money and if designed properly can have the essential characteristicity of permanence and visibility claimed to be important to attract property development along the route, which is compatible with medium-to-high density corridor mobility. To achieve this, the bus industry needs a 'wake-up' call. The opportunities are extensive but the industry is far too traditional (often complacent), often lacking lateral thinking and not pro-active enough. Furthermore, despite the appeal of bus-based transitways, there is still a lot that can be achieved by simple solutions such as adding more buses, adjusting fare schedules, improving information systems, integrating ticketing which is lost in the debate on over whether special rights-of-way for buses as against light rail are better.

The message is simple and powerful: distance our thinking from an obsession with technology and move to study needs as a starting point of inquiry. Do not ask if light rail is feasible, but ask who the stakeholders are and proceed to investigate how they may best be served. Institutionally, the presence of economies of network integrity may force a review of the existing spatially bounded franchised arrangements for bus service provision in cities such as Sydney, London and Auckland. This is the challenge.

CHAPTER 18

THE FUTURE OF EXCLUSIVE BUSWAYS: THE BRAZILIAN EXPERIENCE[¶]

18.1. INTRODUCTION

The 1988–1990 study of bus priority systems for less-developed countries carried out by the UK Transport and Road Research Laboratory (TRRL) and Traffic & Transport Consultants Ltd cited a number of examples in Brazil of Busway Transit providing an effective solution for the need to develop an efficient means of public transportation in urban corridors where demand of between 10,000 and 30,000 passengers/hour/direction exists (Cornwell & Cracknell, 1990). This chapter assesses the current effectiveness of the systems in three of the cities cited in that paper. In order to do so, the chapter includes a substantial discussion of the economic, political, regulatory and operating context in which these systems have developed.

Cornwell and Cracknell defined Busway Transit as:

> … a system that includes a right-of-way for the exclusive use of buses, with at least one section of the busway physically separated from general traffic, and some or all of the following:
>
> (a) a collector/distributor system at one or more ends of the busway, most likely including bus priority measures in the CBD area;
> (b) bus stops (physical layout, management, etc.);
> (c) fare-collection methods (e.g., on or off-board collection);
> (d) bus fleet (vehicle capacity, door configuration, etc.);
> (e) operations (e.g., bus ordering, express services); and
> (f) marketing (passenger information; corporate image, etc.).
>
> (Cornwell & Cracknell, 1990, pp. 192–193)

[¶]This chapter first appeared as an article in the *Transport Reviews.*

This chapter applies the generic term 'busways' to transport systems of this type.

Such systems exist in at least five Brazilian cities. This chapter discusses the history and operation of busways in three of these: Curitiba, Sao Paulo and Porto Allegre. These cities have been chosen as they illustrate a number of major themes in the operation of busways – the relationship between urban planning and the effectiveness of busways; the impact of different regulatory systems; and the capacity of bus-based systems to respond to demographic, political and economic and regulatory change.

Curitiba has been chosen as it has a world reputation for effective urban planning and urban transport. Sao Paulo provides a stark contrast – unplanned, congested and with a contrasting reputation for urban degradation and restricted mobility. Porto Allegre provides an example of the relationship between regulation and the effective operation of busways, and of the capacity of a bus system to adapt to reduced regulation.

Costs and revenues quoted are in Australian dollars, based on a conversion of the Brazilian URV to United States dollars and then to Australian dollars at June 1994 exchange rates. The volatility of the Brazilian exchange rate ensures that these figures can only be used as an approximation of long-term costs and revenues. Other statistics are generally based on 1993 or 1994 results. Discrepancies between the two reflect either rapid growth or statistical error.

18.2. BRAZIL: NATIONAL HISTORY AND PROFILE

18.2.1. History

Brazil is the largest country in the continent of South America, both in terms of physical size and population. The characteristics of the country range from the famous Amazonian rain forest of the central and western regions, to the deserts of the north east, to the rich coastal areas south of the equator.

European settlement followed the discovery of Brazil by Portugal in 1500. Brazil was a Portuguese colony until 1823; an independent empire until 1889; and a Federal republic to the present day. The population is concentrated on the coastal strip from the Equator to the southern border with Uruguay.

The economic strength of Brazil was traditionally based on mineral and agricultural exports. During the 1950s, a substantial industrialisation process commenced, with strong encouragement by the Federal government.

This has resulted in strong, export-oriented automotive, heavy industry, aerospace and military equipment industries. This process of industrialisation has been accompanied by a major population shift to the cities.

The defining event in post-war Brazilian politics was the military coup of 1964. This ushered in a period of centralisation. A civilian administration was installed by the military in 1985, and a democratically elected civilian President took power in 1989. Brazilian politics has been characterised by ongoing tension between the Federal and State governments, endemic corruption, instable economic policies and intense nationalism.

The current political structure is based upon shared power between a Federal government based in Brasilia, 26 State governments and the Federal District of Brasilia and Municipal government. In major urban areas, intermunicipal bodies exist for the purposes of co-ordination of urban development and functions. For the purposes of this chapter, the term 'urban' will refer to the traditional urban area of each city controlled by the Municipal government; the term 'metropolitan area' to the urban area and the surrounding suburbs that are under separate municipal jurisdictions; and 'State' to the State government.

18.2.2. Population Trends

The population of Brazil has increased from 121.3 m in 1980 to 150.4 m in 1990, and it is anticipated to be 179.5 m in 2000 (IBGE, 1990). Concurrently, there has been a major migration from rural to urban areas, with a shift in the urban population from 46% of the total in 1960, to 59% in 1970 and 75% in 1988. The annual urban growth rate nationwide was 4.5% between 1960 and 1980 and 3.6% between 1980 and 1988. Twenty-four million people were involved in internal migration between 1970 and 1980. This has resulted in the formation of major urban areas – in 1970 there were five cities with a population greater than 1 million; by 1987 there were 11 such cities (EIU, 1991).

This survey discusses urban transport developments in three cities:

- Sao Paulo, in the State of Sao Paulo;
- Curitiba, in the State of Parana; and
- Porto Allegre, in the State of Rio Grande do Sul.

Table 18.1 summarises demographic trends and the urban transport infrastructure in these three cities. In addition, car ownership rates and per capita income are somewhat less than West European countries but higher

Table 18.1. Urban Demographic Trends – 1991.

	Sao Paulo	Curitiba	Porto Allegre
Urban population (million)	9.48	1.29	1.26
Metropolitan area population (million)	15.20	1.98	2.94
Metro area (/km^2)	7,951	8,763	5,806
Population density (/km^2)	1,912	567	507
Population growth 1970–1980 (% pa)	3.67	5.34	2.43
Population growth 1980–1991 (% pa)	1.00	2.11	1.05
Urban buses	9,779	1,696	1,930
Metro lines (km)	43.6	Nil	Nil
Urban trains (km)	192.0	Nil	27.0 km

Source: Almanaque Abril (1993).

than developing countries. There is heavy dependence on public transport, especially buses.

The distinction between the 'urban' and the 'metropolitan area' populations reflects the growth of these cities to areas outside of their traditional boundaries. 'Metro Lines' refer to underground, heavy rail services; 'Urban Trains' refer to suburban services operating on existing rail lines.

18.2.3. Regulation of Urban Transport

Public transport in all three cities is regulated by a combination of city (municipal), regional (metropolitan) and State bodies. In all cases the service levels and fares are controlled, but this control is diluted by substantial illegal bus operations (Sao Paulo); competing minibus systems (Porto Allegre); or by services provided within the urban area by operators from the surrounding metropolitan region that are outside of the control of the urban authorities (Curitiba and Porto Allegre).

18.2.3.1. Curitiba

Curitiba has the most comprehensive regulatory regime of the three cities. From 1965, bus transport has been given a pivotal role in the implementation of the city plan. The operation of bus services is controlled by a municipal body – URBS (Urbanizacao de Curitiba S.A.) – which controls not only buses but taxis, parking lots, public shopping areas, markets and bus terminals. URBS acts as a planning body, a regulator and controller of the bus system – collecting all fares but contracting out the operation of the buses to private operators. The centrepiece of the Curitiba operation is the RIT (Rede

Integrada de Transporte – Integrated Transport Network), which consists of a hierarchy of seven bus systems linked through 'Integration Terminals'. The operation of this system is dependent upon total integration of all the bus operations in the city. Fare revenues are pooled and paid to contractors on the basis of the service provided. Contractual payments are based on a complex formula that takes into account the full cost structure of the contractors. Vehicles are provided by the contractors. The only interruption to the control of this system is created by the lack of co-ordination with the transport systems in the surrounding cities (suburbs). To date, only one of these has permitted the extension of the RIT across the municipal boundary. This results in the operation of suburban buses within the urban area. However, they are restricted from conveying urban passengers. The principal disruption caused by this division is the inability of URBS to adequately plan for the metropolitan area, and to strengthen the bus corridors that operate to the urban boundary with the patronage available from these suburbs (URBS, 1994).

18.2.3.2. Porto Allegre

Porto Allegre suffers from having the highest proportion of the metropolitan population resident outside of the urban boundary (57%, against 35% in Curitiba and 38% in Sao Paulo) (Almanaque Abril, 1993). Furthermore, urban transport is provided by three modes – buses, minibuses and an urban rail line. The minibuses provide a competing service on high-frequency scheduled routes charging a 70% premium on bus fares. The urban rail line was built by a Federal body (EBTU – Empresa Brasileira de Transportes Urbanos) during the period of the military dictatorship. It has failed to reach more than 31% of its projected ridership (110,000 pax/day carried vs. a 350,000 pax/day projection), and with the disbandment of EBTU in 1990 is now for sale (ATP, 1994).

Regulation of the urban bus system was formerly heavily influenced by EBTU, which was responsible for developing and supervising bus corridors and providing an integrated network between various bus operators and the urban rail line. The demise of EBTU has removed this layer of regulation.

Urban operations are currently regulated by the Municipal government in regards to routes operated and fares charged. Metropolitan operations are regulated by the State government in a similar fashion, but there is little co-ordination between the two in the areas where metropolitan buses enter the urban area. The effectiveness of restrictions on metropolitan buses operating within the urban area is open to doubt, but the prevalence of flat fare systems and the substantial premium on the fare of the longer distance metropolitan services effectively limits their attraction to urban bus users, even though both groups of operators share in the use of the urban busways. Fares are set by the municipality at a level that covers all operator costs as defined by an analysis of industry cost structures.

In contrast to Curitiba and Sao Paulo, there has been a significant reduction in the level of regulation of urban transport in Porto Allegre. The demise of EBTU has removed the integration formerly provided by EBTU, and this has led to a discontinuation of supervision on the busways; and of fare-free transfers between operators at integration terminals. Furthermore, a relaxation on the limit on the size of minibuses (from 17 to 21 seats) has permitted the growth of competition from this sector. Effective fare pooling is now provided by the operators themselves through the industry association ATP (Transport Companies of Passengers Association of Porto Allegre) rather than by the municipality. Porto Allegre is the least regulated of the three cities.

18.2.3.3. Sao Paulo

The regulation of urban transport reflects the size and complexity of the city (15.2 m residents in the metropolitan area, 5.72 m of which are outside of the urban boundary). There are four major transport systems centred on the urban area – the urban bus system (CMTC – Companhia Municipal de Transportes Coletivos – a municipally owned company); a State underground railway and associated bus network (Metro and EMTU – Empresa Metropolitana de Transportes Urbanos de Sao Paulo S.A.); and two long-distance rail networks that also provide urban services (FEPASA – Federal Railways and CBTU – State of Sao Paulo Railways). Of the 9 million daily passengers on these systems, 67% travel by bus, 22% by Metro and 11% by each of the railway systems (CMTC, 1994). Overlaying these systems are a range of both Municipal and State planning bodies. There is no coherent transport organisation for the whole metropolitan area, although Metro/EMTU has aspired to this role. Municipal planning is now predicated on the assumption that shortages of funds will limit the future role of Metro/EMTU, and that major transport infrastructure development in the city will be initiated and funded from private sources under the direction of CMTC.

The regulation of the urban bus system is controlled by CMTC, which was established in 1947 to acquire the tramway assets of the local power utility. By 1949, CMTC was also operating diesel and electric (trolley) buses. The intention of CMTC was to establish an operating monopoly in the urban area, and this came closest in fruition in 1954 when the company was operating 90% of the city's buses. However, CMTC was overwhelmed by the urban growth of the city during the late 1950s. Private buses re-appeared in 1957, and by 1977 CMTC was reduced to operating 14% of the urban buses. Increased investment increased this proportion to 30% by 1993. In 1994, a process of privatisation was implemented, whereby CMTC totally divested itself of bus operations.

Throughout this period CMTC has functioned as the regulator of the urban bus system, controlling the operation of private buses within the urban area. These operations have moved in stages from a simple licensing to the current system known as 'municipalisation', whereby fare revenues are collected by CMTC and paid to contractors on the basis of a cost formula and passengers carried.

The transformation of CMTC from an operator and regulator to a regulator was primarily the result of the transport policies of Mayor Luiza Erundina de Sousa implemented in 1990/1991. Winning office on a left wing programme that aimed to significantly increase the quality of bus transport in the city (where bus numbers had stagnated at 8,500 for 10 years, despite population growth), the programme included the introduction of free fares ('Tarifa Zero'), the supply of large numbers of new buses (imported from Eastern Europe if necessary) and the 'municipalisation' of fares (i.e., CMTC collecting revenues and paying operators on the basis of resources used). As an adjunct to this, private operators who lacked route licences were invited to provide additional buses on the city's routes.

Whilst the 'Tarifa Zero' was rejected by the municipality, the other aspects of the plan were implemented. This led firstly to a breakdown in regulation, with 3,000 'pirate' buses operating on the city routes without route licences. Secondly, a rapid expansion in the size of the licensed fleet (from 8,500 to over 10,000) and an improvement in quality (from an average fleet age of 8.5–3.5 years) coincided with a period of no patronage growth, due to the economic recession. Fare income remained stable, but costs exploded as operators were reimbursed on the basis of resources provided.

In 1992, an attempt was made to control the 'pirate' operators, with permits being issued for 600 buses. However, this has been only partially effective, with 1,400 unlicensed buses remaining in service in 1994.

In 1993, a new administration was installed, and quickly concluded that this cost explosion would bankrupt the system within six months. Faced with the alternatives of a major fare increase (100% over the existing inflation rate) or privatisation, and noting the major cost advantage of the private operators (a cost per passenger of 67 cents vs. $1.73 for CMTC), a rapid privatisation plan was implemented. This involved the disposal of 3,000 buses (including 470 trolley buses) to private operators and reducing CMTC employment from 27,000 to 800 in 12 months (CMTC, 1994).

CMTC now concentrates on the regulation of the urban bus network, the implementation of new technology and the development of a city-wide system of busways and integration terminals with private sector capital. Metro/EMTU continues to provide the underground rail service (45 km on three lines carrying 2 m pax/day) and an urban bus network that crosses the urban boundary, linking major suburban centres with Metro stations within the urban area.

18.2.4. Fare Systems, Funding and Operator Contracts

In each of the cities the principal means of funding is through the fare box, with only Sao Paulo providing municipal funds to support operating costs. Similarly, each city has a form of fare pooling, whereby revenues are aggregated and distributed on the basis of services provided. Fare systems are based on flat fares, which are in part implemented to ensure social equity for poorer residents who tend to live on the outskirts of these cities.

Fares are generally collected by conductors seated near the rear door. Passengers enter by the rear door to a holding bay; pay the conductor; and pass through to the main body of the bus. Passengers alight from the front door. Sao Paulo operates certain routes on the reverse principle, with passengers paying after entering the front door. Tokens are used for many forms of payment, as inflation rates of up to 40% per month have made coins inoperable as a form of currency.

18.2.4.1. Curitiba

Services provided within the urban area of Curitiba under the auspices of URBS charge a flat fare equivalent to AUD0.53 (URBS, 1994). Periodical fares are set to ensure that the 'average worker' spends no more than 10% of income on transport (Herbst, 1992). Flat fares are a deliberate policy to provide social equity for all residents of the city. Fares are set at a level to ensure that no subsidy is required to cover payments made to contractors.

A central feature of the RIT system is the provision of 16 transfer terminals, where 'fare-free' transfers are available between all services meeting at these points. These 'free' transfers are an essential element of the integration of the city's transport system. The proportion of passengers making fare-free transfers by type of service is set out in Table 18.2.

The free transfer ticket is used by 36.7% of the average weekday patronage. Of the routes that are designed to serve the transfer terminals (all except the 'City Circular' and 'Conventional' services), 46.1% of the

Table 18.2. Curitiba Bus Passengers by Service and Fare Type Weekday Average Passenger Numbers – 1993.

Service Type	Fares Paid to Conductor	Transfer Fares	Total Fares	Proportion of Transfer pax (%)
City circular	5,014	Nil	5,014	0
Conventional	343,585	22,264	365,849	6.1
Feeder	197,649	168,002	365,651	45.9
Intersuburb	94,510	80,470	174,980	46.0
Express	227,138	131,256	358,394	36.6
Speedybus	71,201	138,130	209,331	66.0
Bi Artic Express	57,976	37,684	95,660	39.4
Total	997,073	577,806	1,574,879	36.7

Source: URBS (1993a).

patronage is transferring. Furthermore, these transfers are occurring on the services, which have shown the most patronage growth, and are targeted for further expansion ('Speedybus' and 'Bi Artic Express'). A more detailed explanation of the service types is provided in Section 17.7.

Operator remuneration is provided through direct payments to the operators, calculated on the basis of the volume (km) and type of service (vehicle type) that is provided. Operators are responsible for the full operating and capital costs for their allocated routes. Contract payments are calculated from an analysis of each operator's cost structure, with a capital component based on the age and type profile of the fleet operated. Profit margins are set at 10% of turnover (Worcman, 1993).

18.2.4.2. Porto Allegre

Urban services in Porto Allegre charge a flat fare of AUD0.49 (ATP, 1994). This fare is determined by the municipality on the basis of an examination of the operators' cost structures and patronage numbers. The fare level covers all costs incurred by the system. Table 18.3 indicates the four fare types and their usage.

Revenue is distributed by type of ticket. Operators retain revenues generated by cash and half fares, but receive no compensation for the revenue foregone for student and concession fares.

The 'Transport Ticket' is a periodic multi-operator commuter ticket sold by ATP and valid for use on all urban services. Revenue from the 'Transport Ticket' is controlled by ATP and distributed on the basis of kilometres operated. The fare receives limited government support through an indirect employee subsidy – where the ticket is purchased by the employer, that

Table 18.3. Fares Sold Per Month by Type – 1994.

Type of Fare	Number Sold (millions)	Proportion (%)
'Transport ticket'	15	43
Cash fares	10	29
Student half fares	5	14
Free (elderly and others)	5	14
Total	35	100

Source: ATP (1994).

portion of the fare over 6% of the monthly salary of the employee is tax deductible. Both the municipal operator and the private operators participate in this arrangement.

Transfer between buses is not facilitated. The 'Transport Ticket' does enable this, but Integration Terminals established under the EBTU period no longer provide for 'fare-free' transfers. The elimination of 'free transfers' has had no measurable impact on patronage.

18.2.4.3. Sao Paulo

The flat fare applicable in Sao Paulo is AUD0.88. Through fares to the Metro are also available, as are periodical tickets. A major Integration Terminal at Santo Amaro provides 'fare-free' transfers to services in that area, but this is not a dominant feature of the overall transport network. All fare revenues are collected by CMTC and distributed to contractors by a formula that allocates a cost/passenger for the routes served. Thus routes with short distances and high average loadings are paid a lower rate/pax than long routes with lower average loadings. These fares contribute 88% of the costs of operating the bus system – the balance is provided as a subsidy by the municipality through CMTC. Two percent of the funds distributed by CMTC are targeted towards operators that achieve quality and productivity benchmarks set by CMTC (CMTC, 1994).

18.2.5. Ownership Structures

Bus operations are provided exclusively by private operators in Curitiba and Sao Paulo, with a small municipal operation in Porto Allegre.

18.2.5.1. Curitiba

There are 10 private operators in Curitiba providing 1,250 buses for URBS services. These operate under contracts that have evolved from original contracts established in 1955. Each contractor has routes in a geographic 'slice' of the city. Contracts are 'rolled over' on expiry with no tender process. Efficiency is maintained by tight supervision of each company's finances and by 'benchmarking' between operators (URBS, 1994).

18.2.5.2. Porto Allegre

Fifteen companies and one municipal operator provide urban services with 1,360 buses (258% or 19% are owned by the municipality). In addition, there are 403 minibuses operated by 200 owners on competing, scheduled route services. A further 700 buses from the metropolitan area also operate into the urban area. Route allocations are determined by the municipality. However, it is currently proposed that route allocations be tendered in 1995. There is considerable confusion regarding the relationship between the municipality and the private operators, which was unresolved in June 1994.

18.2.5.3. Sao Paulo

CMTC currently supervises operations by approximately 11,000 buses in the urban area. All services are provided by private companies. These operate under a range of contract types, depending on the history of the operation:

(1) private operators that existed in 1993;
(2) private operators that tendered for services in 1994 but provided their own equipment;
(3) private operators that tendered for services in 1994 but lease equipment from CMTC;
(4) 'pirate' operators that received temporary permits in 1992; and
(5) 'pirate' operators that continue to operate without permission.

The goal of CMTC is to establish a standard eight-year contract let by tender. With new projects these contracts may involve the provision of substantial infrastructure in the form of dedicated bus roadways, in addition to the supply of buses and operating services.

18.2.6. Urban Planning

Brazilian cities have experienced major expansion during the past 50 years, resulting from both natural increase and internal migration. Cities have responded in two ways to this process – those that have allowed planning processes to be overwhelmed by the growth, and are now engaged in trying to 'insert' urban transport systems into an existing city structure; and those that have managed growth around transport corridors, such as Curitiba. The role of busways in the three cities examined is predicated by their position in the urban planning process. For this reason, it is not necessarily appropriate to compare systems in Curitiba with the Sao Paulo or Porto Allegre, unless the role of urban planning in Curitiba is accounted for.

18.2.6.1. Curitiba

Population growth in Curitiba has taken a small capital city of an agricultural state with a population of 140,000 in 1940 through to a medium-sized city of 500,000 in 1965 to today's urban population of 1.29 m and a metropolitan population of 1.98 m (Herbst, 1992).

The key decisions in the management of this growth were made in 1965, when a traditional urban master plan was jettisoned in favour of a scheme that would concentrate high-density growth along five slender corridors radiating from the city centre. This decision was rigidly enforced by the Municipal government, and supported by land resumptions. High-rise developments were restricted to a four-block corridor on either side of these 'transport axes'. Much of the subsequent development (including 17,000 low-income units) was then constructed by the Municipal Company for Housing (COHAB).

This development was strengthened by preserving the historic downtown area, through pedestrianisation of a central 17 block area, and encouraging the development of markets and 24-h shopping precincts. With retailing based in the CBD, industrial employment was similarly channelled to the Curitiba Industrial City (CIC). This development, commenced in 1973 as a model industrial park, currently generates 20% of the jobs in the metropolitan area. Public transport was facilitated by concentrating residential development on corridors that featured exclusive bus lanes, and concentrating employment in only two centres (CBD and CIC).

This development was overseen by the remarkable political stability of the Municipal government. Mayor Jaime Lerner, first appointed under the military dictatorship in 1971, held office until 1992, through successive changes in Federal governments and the introduction of democracy. The combination of a visionary mayor with an absolute commitment to the city's planning goals with 21 years of stable government provided a platform for orderly development that no other Brazilian city could match during this period of major political and economic change.

This combination of establishing clear planning goals prior to the major development of the city, with consistent management and political stability, has provided the platform upon which the Curitiba transport system has been developed.

18.2.6.2. Porto Allegre

The planning base for Porto Allegre provides a significant contrast to that of Curitiba. As an older city built around a harbour foreshore, planning was restricted by geography. Furthermore, the political structure of the city is fractured by the high proportion of the metropolitan population that is resident outside of the area served by the urban government (57% compared to 35% in Curitiba).

Further complexity was added by the strong role played by the Federal agency EBTU. The EBTU master plan – based upon the urban railway and the development of exclusive bus roadways – floundered with the disbandment of the Federal body in the decentralised political climate of 1990. The city allowed the co-ordinating aspects of this plan to flounder, and whilst the operators were successful in developing a co-ordinated fare regime, other aspects of the plan lapsed. The current operating environment in Porto Allegre reflects these changes in political commitment to integrated transport in the city.

18.2.6.3. Sao Paulo

As one of the world's first Third World 'mega-cities', Sao Paulo has long been a by-word for the negative impact of massive population growth in an ill-prepared urban environment. Although growth rates are lower than in the other two cities, the current annual increase of 1% will still add 1.25 m residents (equivalent to the urban populations of either Curitiba or Porto Allegre) over the next five years.

As with Porto Allegre, political power has been divided, both between the urban Municipal government and the surrounding cities, and between the Municipal and the State governments. This has been compounded by the development of major transport infrastructures by each group, with CMTC pursuing exclusive bus roadways; the State government building the Metro underground rail lines; the 'cross-border' EMTU exclusive bus network and operating one of the two metropolitan rail systems (CBTU); and the Federal government operating a second metropolitan rail system (FEPASA). Further planning breakdown resulted from the disparity between the goals of the Municipal bus operator (CMTC) to provide the total system; and the reality of a constant requirement to rely on the private sector to meet the transport demand. Co-ordination between these organisations has been attempted by a series of planning bodies, none of which has produced a plan that has been capable of implementation. In particular, all of these plans suffered from the assumption that a full 147 km Metro rail system would be constructed, when in fact only 45 km is operational and further growth in proceeding at a glacial speed. This in turn reflects Federal priorities in the urban transport area and the position of the World Bank in funding such developments (SMT, 1993b).

This disjointed transport planning framework reflects the general failure of urban planning in Sao Paulo during an extended period of massive population growth. As with Porto Allegre, the development of urban busways in Sao Paulo must be assessed in the context of both this population growth and planning failures.

18.2.7. Development and Operation of Busways

The development of busways (exclusive bus roadways) in these three cities has been driven by five forces:

(1) The relentless growth of population, particularly on the extremities of these cities, that require an efficient transport system.
(2) The requirement for operational efficiency, as transport systems required rapid expansion during a period of on-going national political and financial chaos, with hyperinflation, currency crises and unmanageable deficits at local, State and Federal levels.
(3) The influence of the World Bank, which during the 1980s turned against 'showcase' urban rail projects, on the basis of the benefit/cost ratios of such schemes.
(4) The strength of the local bus manufacturing industry, which has developed into the largest in the world.
(5) The success of the Curitiba model, in terms of both efficiency and service delivery.

Each city has produced different variations on the busway theme, with Curitiba and Sao Paulo pushing bus technology and operating capacity to new limits. Porto Allegre, which at one stage operated the most intense busway in the world, has fallen behind the other two cities in innovation and operations, as the regulatory regime has altered and political support withdrawn.

18.2.7.1. Curitiba

18.2.7.1.1. From Busways to the System – the Development of the RIT. The 1965 decision to concentrate urban development along radial corridors first impacted the Curitiba bus system with the introduction of the Express bus routes in 1974. Twenty buses operating with a distinctive red colour scheme were introduced on a 19.8-km North–South exclusive bus lane, carrying 25,000 pax/day. This route replaced eight existing conventional bus routes. The Express routes were fed by a 45 km of feeder services. Further Express routes – all travelling in exclusive bus roads outside of the CBD – were introduced in 1976 and 1979, and continuing development led to the existing network of 56 km of Express routes, served by 208 buses, carrying 454,000 passengers daily. These services are fed by a further 300 km of feeder services.

However, the development of these Express bus routes on exclusive bus lanes has only been one element in the RIT system. Just as the system cannot be assessed independently of the urban planning context in which it operates, neither can these busway services be considered independently of the supporting initiatives for non-busway services. In 1993, less than 50% of bus passengers in Curitiba were using the busway services, although in terms of passenger per kilometre the proportion would have been higher.

The first of these initiatives was the 1979 introduction of the 'Interbarrios' or cross-suburban services. These linked the Express route termini by means of cross-suburban routes. In 1993, there were seven of these connecting routes, carrying 11% of the daily patronage.

In 1980 RIT was established, with the implementation of the first Integration Terminals (manned, covered, barrier-free transfer points between Feeder, Express and Intersuburban bus services), the 'free transfer' between services at the terminals and the flat 'social fare'. The 16 terminals now in operation form the foundation of the system, facilitating transfers between the various elements of the RIT system.

In 1991, a third principal form of corridor was added to the Express lines and the Interbarrios services – the 'Linha Direta', or, as it is popularly referred to, the 'Ligerinho', or 'Speedybus'. The Speedybus has proven to be the 'engine' of much of the recent growth in patronage in Curitiba and, curiously in a city that has a world recognised series of busways, does not make use of any of these exclusive bus lanes. The Speedybus links the principal transfer points on the system (the Integration Terminals), a limited number of major stops and the CBD area with a series of high-speed bus routes. These avoid the busways, as the more frequent stops of the Express buses would impede operating speeds, and as a number of the busways (particularly the North–South corridor) are heavily congested with buses. Unlike Sao Paulo, the Curitiba busways have no provision for buses to overtake. To further increase operating speeds, the Speedybus system is supported by purpose design bus stops ('Tubes'). These 'Tubes' function as ministations on the bus route. Passengers pay a seated conductor on entering the tube, and board the bus across a step-free ramp. This minimises the delay at stops. The Speedybus services operate at an average speed of 34 km/h (against 22 km/h for the Express buses), and have reduced daily travelling times for many passengers by over an hour. This improved service has led to rapid growth, with 28% of Speedybus passengers transferring from private cars. In June 1994, the Speedybus network was served by 156 buses that carry 300,000 passengers per day (URBS, 1994).

The success of the Speedybus illustrates three characteristics of the Curitiba system. Firstly, patronage growth in Curitiba has resulted in part from tailoring service provision to market needs (in this case reduced travel times), even when new services did not use all of the existing infrastructure (the bus lanes). Secondly, the growth of patronage and services on the busways has reached the point where they now suffer from congestion that is impeding further growth. Thirdly, the high mode split in favour of bus transport for commuters (75% of daily commuters travel by bus), has resulted in low traffic volumes that allow higher average speeds for buses on the general road system than on the exclusive bus lanes. Each of these characteristics supports the contention that the busways are only one factor contributing to the success of the RIT.

Congestion on the busways, created both by the volume of buses in use and the impact of intersections on through bus traffic, is the major current issue to be resolved in the development of the RIT. At one stage URBS saw the busways as an interim step to the development of a light rail (LRV) network. It was considered that only LRV could convey the predicted volumes at the speeds required. However, two developments have led to the abandonment of LRV plans – the relative costs of LRV, and technological advances in bus design and operating techniques that have significantly lifted the capacity and speed of busways, for little additional cost.

These advances were demonstrated through the upgrading of the Boqueirao Express route in 1992. This project consisted of combining the advances already implemented with the 'Speedybus' – the tube stations – with biarticulated buses. The tube stations were installed at every stop along the Boqueirao to City route – 11 km of exclusive busway. The buses were designed to maximise both loading speeds and capacity, with five doors designed to integrate with the tube station entrances, and a total capacity of 270 passengers. This project demonstrated that this combination could deliver a high quality, fast and high capacity service at a minimal capital cost to the municipality. The Boqueirao route is currently operated by 33 biarticulated buses. There are 30 tube stations, spaced at approximately 500 m intervals, and three integrated transfer terminals on the route. At the current frequency, 10,000 pax/h are transported in the peak direction. URBS estimates that up to 22,000 pax/h could be efficiently transported at an equivalent speed to the current Express network (22 km/h) with this system.

The costs of the system to URBS have been minimal. Firstly, the use of large capacity biarticulated buses reduces the overall bus and staffing requirement. The 33 biarticulated buses replaced 66 conventional vehicles, generating a 12.5% reduction in costs/passenger (URBS, 1993b). Thus, the operating costs of the enhanced busway is less than the existing system, which itself meets all operating and capital costs without subsidy. Furthermore, the infrastructure cost for the Boqueirao was AUD2.7 m for the entire route. The estimated cost of an LRV system was AUD21 m/km, or nearly eight times greater (URBS, 1992). Given that the biarticulated busway is estimated to have the capacity to meet anticipated demand, Curitiba has abandoned all plans to move away from bus-based technology, and proudly promotes this system as their 'surface subway'.

The fundamental remaining difficulty for the RIT is the integration of the Curitiba urban bus network with the surrounding metropolitan area. Although one Speedybus route has been expanded across the city boundary, and plans exist for further extensions of each of the five trunk routes, political differences remain an effective barrier.

18.2.7.1.2. RIT Operations. The urban area of Curitiba has the second highest level of car ownership in Brazil, with 562,000 motor vehicles, or more than one car per household (Worcman, 1993; URBS, 1994). Within this environment, the urban bus network carries 997,000 pax/day (1,575,000 if transfers are counted twice) (URBS, 1993a). Seventy five percent of the city's commuters and 50% of all of the residents use the bus on a daily basis (The Economist, 27/4/1993 and Worcman, 1993). Table 18.4 outlines the current breakup of passengers between the various types of bus service.

The RIT system does not carry the high passenger per hour volumes that are experienced on busways in Porto Allegre and Sao Paulo. This reflects the marketing emphasis of URBS, which ensures that the system offers an attractive service to passengers by avoiding 'crush loadings', the ability of Curitiba's planners in maintaining capacity growth in the system at a rate in excess of demand growth; and the effect of service innovations that have reduced congestion on major corridors (such as the Speedybus). The most congested corridor in 1994 was the southern sector of the North–South

Table 18.4. Service Characteristics – 1993.

Type of Service	Number of Routes	Fleet Size	Daily Passengers	Percentage of Total (%)	Average Speed (km/h)
City circular	2	11	5,014	0.3	N/A
Conventional	92	399	365,849	23.2	17
Feeder	115	328	365,651	23.2	N/A
Intersuburb	7	125	174,980	11.1	N/A
Express	19	179	358,394	22.8	22
Speedybus	10	135	209,331	13.3	34
Bi Artic Express	2	29	95,660	6.1	22
Total	247	1,206	1,574,879	100.0	

Sources: URBS (1993a, 1994).

route, carrying 11,000 pax/h in the direction of peak, with a theoretical capacity of 12,650 pax/h. Current loadings on the Boqueirao route approach 10,000 pax/h, with a theoretical potential of 22,000 pax/h. These existing capacities must be assessed in the context of the high average speeds currently achieved. The theoretical loading projections may be not be compatible with the current operational speeds.

The RIT system has clearly achieved many of the primary goals of an urban transport system – a high mode share in a city with significant car ownership; patronage growth matching population growth; and an effective network of services meeting market demands. Although 'Curitibanos' are often criticised for overselling their city, the effectiveness of their bus system justifies the city's reputation as an example of effective land-use and transport planning, and creative and efficient provision of transport services.

18.2.7.2. Porto Allegre

Exclusive bus roadways were a key plank in the policies implemented by the EBTU in Porto Allegre between the late 1970s and 1990s. A total of 42 km of these lanes were constructed in the medium lanes of five arterial roads serving the CBD. The capacity of these busways was further enhanced by the institution of a 'convoy' system, to ensure that buses used the roadway in a pre-ordered pattern, to reduce delays at intermediate stops. Central organisation was necessary as each of the lanes was used by a number of private and one municipal company (ATP, 1994).

As an early example of the busway system, Porto Allegre attracted worldwide attention. In particular, two of the bus lanes (Farrapos and Assis Brazil) were noted as carrying very high loads in the peak hour (26,100 per hour Assis Brazil and 17,500 per hour Farrapos). Furthermore, this was achieved at reasonable average speeds (22.7 and 19.7 km/h, respectively). These results were reported by Transport and Road Research Laboratory study in 1990 (Gardner & Fouracre, 1990). The Porto Allegre results were the highest recorded in this international study in terms of peak hour loadings and the second highest in terms of average speeds. Results such as these have influenced bodies such as the World Bank to reduce support for rail-based solutions in Third World cities.

Unfortunately, the Porto Allegre busways can no longer produce these results. In 1994, the Assis Brazil was still used by 20,000 pax in the peak hour, but the 280 buses per hour that carried these passengers were moving at an average speed of only 12 km/h. Operators represented by the ATP did not provide any explanation for this decline. It is possible that the earlier result was 'oversold' by EBTU, as the study was conducted during the dying stages of that organisation's existence. Alternatively, the removal of the EBTU 'organisational umbrella' over the operations of many companies may have led to a substantial decline in service quality. In particular, the convoy system has not been maintained, and the fare-free transfer interchanges no longer function in this manner. The current capacity of these routes is similar to that achieved in Sao Paulo, and may reflect the maximum speed that is possible when 4.7 buses per minute are operating on a single lane over 4.5 km with stops every 560 m.

The current performance of these busways in Porto Allegre gives credence to the policies of URBS in Curitiba, where enhanced performance is considered to be possible only with substantial upgrades to technology and operating methods. The major technological differences in Curitiba are the use of higher capacity buses (five-door 270 passenger double-articulated in Curitiba and one-door 110 passenger conventional rigid buses in Porto Allegre) and 'tubes' at bus stops that reduce standing time with prepaid fares and 'no step' entry. The principal operational difference in Curitiba is the operation of only one route on the corridor, with interchange by passengers required at either end and at set intermediate transfer stations on the route. This eliminates the requirement for passengers to choose their bus at the intermediate boarding points, which increases dwell times by buses at stops. The 'convoy' system in Porto Allegre had attempted to resolve this obstacle, by enabling passengers to predict the order in which buses on different routes would arrive at each stop, and thus minimising the confusion created when a large number of buses arrive simultaneously. The breakdown of this system, and the slow boarding times at stops, undoubtedly make a major contribution to the slow speeds achieved on these busways.

These differences reflect the political environments of the two cities. Curitiba RIT system developed during the 21-year 'rule' of a charismatic mayor committed to designing a city that could prosper without dependence on private transport, and has bequeathed a powerful ethos to his successors. There is little uncertainty in regard to either future planning directions or political support in Curitiba. By contrast, the bus operator's in Porto Allegre are characterised by uncertainty (regarding contract term; biased administration of route allocation; competition from minibuses), and are focussed on ensuring continuing financial viability. Whilst this has led to the development of an innovative fare pooling arrangement, it has undermined the capacity of the city to offer residents a comprehensive transport system.

18.2.7.3. Sao Paulo

Four busways exist in Sao Paulo – three operated by the municipality (CMTC) and one 'cross-border' system by the State (EMTU). These two operators have both developed these busways as elements in a larger plan, although political instability, lack of resources and planning inconsistency have robbed these plans of long-term coherence.

From the mid-1960s, parallel bus- and rail-based plans were developed to provide Sao Paulo with an adequate urban transport system. From 1966, concrete steps were taken to construct the Metro – a planned 147 km network of high-speed underground rail lines. The initial 42 km of this system was implemented by the early 1980s, but progress was then halted, and only a further 3 km has been developed during the past 10 years. Concurrently, a network of 33 trolley bus routes was planned, published as SISTRAN in 1975. These routes were to be characterised by dedicated bus lanes and Transfer Terminals. However, progress was slow, and only one route was partially implemented by 1982. A further plan was published in 1983 (PAI) to develop four corridors, again based on trolley buses, terminals and bus lanes. Construction commenced on one corridor (Santo Amaro – Avenue 9 de Julho) in 1985. This was followed by a further plan (PMT), which aimed at 23 corridors and 28 Integration Terminals, linked to the Metro. By 1987, one of the two major terminals on the Santo Amaro route had been completed. A further plan was announced in 1989, again based around exclusive bus lanes. In 1990, transport planning was subsumed under the 'Tarifa Zero' debate, although in 1991 the Vila Nova busway commenced partial operation. In 1993 a further plan was released – 'Programa de Corredores e Terminais de Integracao'. Unlike the previous plan, this assumes the Metro will not be constructed, and relies on private sector capital to construct and operate the busways (SMT, 1993b).

Table 18.5. CMTC Busways in Sao Paulo – 1994.

	Paes de Barros	Santo Amaro Avenue 9 de Julho	Vila Nova Cachoeinha
Year of opening	1980	1987	1991
Type of bus	Trolley	Trolley and diesel	Diesel
Length	3.4 km	14.6 km[a]	11.0 km[b]
Terminals	1	1	2
Overtaking lanes	No	Yes	No
Busway Rtes[c]	6	27	14
Number of buses	61	372	159
Buses/peak hour	30	250[d]	75
Pax capacity/hour	3,000	25,000	8,250
Peak hour operating speed	N/A	AM: 21.0 km/h PM: 11.2 km/h	AM: 23.0 km/h PM: 16.0 km/h

Sources: SMT (1993a, 1993b).
[a]Of the 14.6 km, only 11.0 km is exclusive bus roadway.
[b]Of the 11.0 km, only 5.5 km is exclusive bus roadway.
[c]Includes both trunk routes (using the corridor) and associated feeder routes.
[d]In addition, up to 50 illegal buses use this corridor per hour.

Through this period of instability CMTC has constructed three busways, one of which ranks as amongst the busiest in the world. Table 18.5 outlines the operating characteristics of these routes.

The fourth system in Sao Paulo – EMTU corridors between Sao Mateus, Jabaquara (Metro) and the city of Sao Bernardo do Campo – operates a mixture of trolley and diesel buses through four major terminals – one of which is linked to the Metro. Operating statistics were not available, although the outer suburban nature of the route and the observed low density of operation indicate that it operates in a different environment from the CBD-based busways in Curitiba, Porto Allegre and Sao Paulo discussed above.

The Sao Paulo operation confirms the difficulties that conventional busways have in moving large numbers of passengers at reasonable speeds. In this respect, the Santo Amaro busway has similar characteristics to the Porto Allegre busways. Efforts have been made to improve performance on the Santo Amaro route – overtaking lanes are installed at all stops; four sets of trolley wires enable 'express' and 'all stops' services to be operated; and the terminal at Santo Amaro itself is comparable to those in Curitiba. However, the volume of traffic both on the busway and at intersections, and the inability of CMTC to control illegal operation, has resulted in constantly decreasing operating speeds (PM speeds have dropped 33% in four years);

Express buses operating no faster than All Stops buses; and buses on the busway travelling no faster than the surrounding traffic flow (average speeds for buses on the exclusive bus lanes are 16.0 km/h, whilst average speeds on the normal road network are 17.6 km/h) (SMT, 1993b).

The performance of the Vila Nova busway reflects an effort to introduce new operating methods that parallels the Curitiba experience. Bus stops on this route are fitted with platforms that enhance boarding times. However, there is no equivalent to the 'Tube' station that enables pre-payment of fares, and the vehicles used are conventional rigid urban two-door buses modified for use on the route.

In contrast to both Curitiba and Porto Allegre, none of the CMTC busways is complete. The Paes de Barros corridor is but a small sector of the SISTRAN network planned in 1975. As such it links two major thoroughfares approximately 4 km from the CBD terminus, but of itself links no other major transport terminal, and all services using the corridor also use the conventional street network. Similarly, both the Santo Amaro and Vila Nova corridors are punctuated by sections on non-exclusivity, which seriously compromise the operation. Furthermore, all three corridors have poor road surfaces, with only Santo Amaro having concrete standing areas at bus stops.

For these reasons, each of these corridors performs poorly. They have been crippled by inconsistent planning, partial construction, inadequate maintenance and poor supervision. Although the volumes carried are high, the service quality is poor.

From an operational viewpoint, the contrast between these cities confirms that for busways to play a role equivalent to rail-based systems, it is necessary for the system to be supported by

(1) effective long-term planning, to ensure network integrity;
(2) maximum use of innovative operational techniques and enhanced equipment; and
(3) enforcement of exclusivity and co-operation between operators.

It is clear that the more the busway approaches a railway in terms of basic infrastructure (stations, terminals, exclusive right-of-way and high capacity), the more effectively it performs. It is also clear that there can be no real comparison between either capital or operating costs between the two modes, as busways can be constructed at a minimal cost and, given adequate patronage, operated by the private sector without subsidy. Whilst rail-based systems can match the busway in operational characteristics, they cannot replicate this economic efficiency.

18.2.8. Brazilian Busways in the Future – Current Proposals

Although population growth rates in these three cities are declining, all three are anticipating the need to upgrade the existing public transport system. Plans in both Curitiba and Sao Paulo aim to build extensive new busways, incorporating integration terminals, stopping platforms, high-capacity vehicles and improved ticketing technology. Plans in both cities rely on private sector financing to meet capital costs, and both assume that the resulting systems will not only deliver an improved public transport product, but also earn a financial surplus. Plans in Porto Allegre concentrate on re-orienting the bus route network to a less-centralised pattern, and do not include new busway proposals.

18.2.8.1. Curitiba

The major challenge facing URBS in Curitiba is adapting the North–South busways to the current volume of traffic. Services on the route are by conventional rigid and articulated buses, with no platforms at stops. This route is served by seven Express and four Speedybus routes, which are fed by four Intersuburban and 53 feeder routes. The Express and Speedybus routes in the northern sector are currently used by 85,000 passengers/day, and 60,000 daily passengers use the Feeder routes to the three Integration Terminals. In the southern sector, 160,000 daily passengers use the Express routes, with 130,000 passengers using Feeder buses to four terminals. The maximum hourly patronage for the bus lane is 11,000 pax/hour/direction. An additional 62,000 daily passengers use ‘Speedybus’ services that parallel the exclusive bus lanes on this route (URBS, 1993a). These volumes are considered to be the maximum that this operating system can efficiently handle. Two capacity restraints exist – the first on the bus lane, where capacity for growth is restricted; and the second for the general traffic on the cross roads at intersections, where the constant flow of buses impedes traffic flow. A solution to these restraints must therefore involve both increasing the capacity of the bus lane and reducing the number of buses in use.

The proposal to relieve this congestion is to modify 19 km of the busway on the model of the Boqueirao route, with the introduction of biarticulated buses, the construction of ‘tubes’ at all stops and the extension of the exclusive lane through the CBD area to serve three new terminals. This will require the purchase of 67 new buses, at a cost of AUD41 m, the construction of 56 ‘tubes’ (AUD3.4 m), the modification of six existing terminals (AUD1.2 m) and the construction of three new terminals (AUD1.9 m). Of this total cost of AUD47.5 m, the private contractors will contribute 86%

(AUD41 m for the vehicles) and the Municipal government the balance. This infrastructure cost will be AUD0.342 m/km. The cost/passenger of operating the system is anticipated to be 6.8% below that of the existing system. The number of vehicles operated per peak hour will reduce from 91 to 44, and the average speed will marginally increase from 18.1 to 18.6 km/h. The AUD47.5 m cost of the proposal compares to an estimated AUD400 m for an equivalent LRV line (URBS, 1993a, 1994). As the financial commitment required by the municipality is small, and as the political support for the RIT is strong, there is no anticipation that the project will face undue delays. Furthermore, all of the technology and operating systems are currently operating on the Boqueirao route.

That URBS considers it necessary to substantially upgrade this route with passenger numbers of 11,000 pax/h/direction suggests that such volumes are the level at which conventional busway systems reach their capacity limit.

18.2.8.2. Porto Allegre

As already discussed, the fragmentation of the political structures in Porto Allegre, and the vacuum left by the collapse of EBTU, has left the city without a coherent plan to upgrade and further develop the busway system. Furthermore, commercial growth in the city is now concentrated in six subregional centres, which are not directly served by the CBD-oriented busways. Current studies indicate that these developments have redirected 30% of the demand away from the radial routes, but the current route structure only supplies 10% of capacity to cross-regional services. This restriction in part reflects the desire of the municipal regulators to reserve these growth routes for the municipal company. These restrictions are preventing the system from developing in a manner that meets the new demands created by decentralisation. No current proposals exist to extend the busway system, or even to re-organise the operations to return service levels to those achieved under the supervision of EBTU.

18.2.8.3. Sao Paulo

As always in Brazil, it is in Sao Paulo that the most ambitious plans exist. However, the foundations for the 1993 'Programa de Corredores e Terminais de Integracao' (PCTI) – (SMT, 1993b) are a realistic assessment of the probable failure of the State-funded Metro to expand, and a reliance on private capital to meet the construction costs of the new busways and terminals. These may enable the proposal to reach fruition despite the political fragmentation of the city and the ongoing financial disorder at every level of government in Brazil.

The PCTI has been developed on the following assumptions:

(1) The CMTC bus system will remain the backbone of the city's transport network, transporting 70% of daily passengers.
(2) The 1992 expansion plans for the Metro (from 43 to 83 km) are unlikely to be implemented due to budgetary constraints.
(3) The private sector, having absorbed the operation of the 3,000 strong CMTC bus fleet in 1994, will have the capacity to develop a series of major bus corridors on a BOOT (Build, Own, Operate, Transfer) basis, without a requirement for CMTC funds.
(4) The subsequent operation on the corridors will generate a financial surplus for CMTC.
(5) CMTC will continue to control the planning and operational aspects of the system.

The objective of the PCTI is the construction of 188 km of busways on 16 new corridors with operations commencing by 1996. The operating model is similar to that of Curitiba, with specialised vehicles providing trunk line service to which passengers transfer in terminals from co-ordinated feeder routes. Two articulated buses operating in convoy will be used in lieu of biarticulated buses. Bus stops will incorporate a platform, as with the current Vila Nova service. The current turnstile-based ticketing system will be replaced by a magnetic system. Stops will be placed at 500 m intervals. The new terminals will be sited to maximise co-ordination with the Metro and EMTU systems. 1,100 new articulated buses will replace 2,400 buses currently in use on these routes. An average speed of 25 km/h is anticipated, an increase from 18 km/h currently achieved on these routes. This will save passengers an average of 45 min/day. Vehicles will transport an average of 1,800 pax/day, compared to the current average of 700 pax/day (SMT, 1993b).

Financial projections have indicated that the full costs of the system can be amortised over eight years. Construction costs for the busways are estimated at AUD170 m, or AUD0.9 m/km. It is assumed that the cost per passenger of the system will be 22% below that of the conventional system, or 71 cents/pax. The full construction and vehicle costs are to be met by private contractors, who will bid for an eight-year contract to build and operate the busway.

There are many parallels between the proposals for Curitiba and Sao Paulo. Both are premised on an operating system based upon transfer terminals, feeder buses and trunk express routes. Both assume that all bus stops will include platforms, principally to improve boarding times. As a result of this, both assume that a dedicated fleet of vehicles will be used. Both see the capital and operating costs being fully covered from the fare-box. In each city, improved financial performance will result from higher vehicle utilisation levels, through higher speeds. The essential contrast between the proposals is that Curitiba will be adding at the margin to an existing system, whereas Sao Paulo will largely be implementing a comprehensive busway system for the first time. Some doubt must also exist that the Sao Paulo network will be constructed as planned, given the history of major infrastructure projects in the city.

18.3. CONCLUSION

The experience of these operators in Curitiba, Porto Allegre and Sao Paulo supports the contention that, under appropriate regulation, organisation and capital investment, bus-based transit systems are capable of transporting large volumes of passengers at reasonable speeds for minimal capital and operational costs. Appendix 18A illustrates this capacity by a comparison of the volumes achieved by busways in these cities with a number of heavy rail corridors in the Sydney metropolitan region.

However, it is equally clear that busways only function as efficient high-volume transport corridors where the operations are adapted from traditional bus practice and where substantial infrastructure investments are made in bus stops, terminals and vehicle types. Certain advantages of busways over rail-based systems (such as the avoidance of transfers at terminals; the use of standard equipment) may correlate negatively with the capacity the busway can achieve. Certainly, the most successful high-volume busways in Brazil require both passenger transfer and specialised equipment. On the other hand, where busway systems are based merely on providing road space for operators to utilise (as in Porto Allegre), this results in low operating speeds and productivity.

Although previous research has suggested that busways on the Porto Allegre model could efficiently transport 39,000 passengers/hour (Cornwell & Cracknell, 1990), operating experience in Brazil does not confirm this figure. The current maximum volume carried on an efficient busway (i.e., with an average speed greater than 20 km/h) is 11,000 pax/h in Curitiba, and where volumes exceed this, the average bus speed drops towards that of the surrounding traffic flow. It remains to be seen whether the Curitiba 'surface subway' and the proposed systems in Sao Paulo will be capable of both moving 22,000 pax/h volume and maintaining average speeds in excess of 25 km/h, as predicted.

Nevertheless, the existing busways can provide an equivalent capacity to an LRV system, at a fraction of the capital costs. As Cornwell and Cracknell concluded:

> The capacity of a well designed and efficiently managed busway can be equivalent to that of an LRT, on a comparable basis (for example, degree of segregation; stop spacing) (Cornwell & Cracknell, 1990, p. 195)

and that

> … it should be noted that despite the current wave of LRT proposals, and the considerable resources which have been invested in various LRTs (Manila, Hong Kong, Rio de Janeiro etc.), the consultants know of no LRT in a less-developed country which outperforms the busways surveyed in terms of productivity (passenger volumes x speeds) (Cornwell & Cracknell, 1990, p. 200).

In interpreting comparisons between LRV and busway systems, it is important to note the contrast between 'theoretical' capacity and capacity achieved.

The Brazilian experience also supports the key interrelationships that exist between successful busway operation and long-term planning, land use, appropriate regulation and political stability. Where busways have been implemented in isolation from coherent planning and land-use strategies, the results have been either partial, inefficient systems (as in Sao Paulo) or overcrowded systems, which cannot adequately meet demand (Porto Allegre and Sao Paulo). The outstanding feature of Curitiba is that an integrated system of bus service types has developed in response to a clear and structured urban plan. This combination of a planning-driven 'bus-friendly' urban form and a marketing-driven, innovative bus operation has provided Curitiba with an excellent transport system. The busways are no more than an important element in this process. Furthermore, the contrast between Curitiba and Sao Paulo is not so much in the preparation of plans, but in their consistent implementation over a 30-year time frame. Political stability has enabled the planning and innovation in Curitiba to deliver results. Similarly, the effectiveness of busways is also dependent on an integrated regulatory regime. The decline in the effectiveness of the Porto Allegre busways results from the removal of the 'umbrella' regulation of EBTU. Although the multiple operators have effectively developed a system-wide fare system, they have not been able to maintain the efficiencies of the busways. Similarly, a major restraint on the Santo Amaro busway in Sao

Paulo is the presence of 'pirate' bus operators, who overload the capacity. An efficient busway requires a firm and coherent system of regulation.

The busway systems in Curitiba, Porto Allegre and Sao Paulo provide an illustration of the strengths and weaknesses of this transport mode. Although these systems have operating weaknesses, and although many aspects of their operation are not transferable to other national contexts, they nevertheless provide working examples of the capacity of the bus to provide cheap and efficient solutions to major urban transport problems.

APPENDIX 18A. INTERNATIONAL COMPARISONS

Volume of Passengers Using Transport Corridors in the Peak Direction of Travel during the Peak Hour.

City	Mode	Line	PAX/hour
Curitiba	Busway	Pinheirinho	11,000
Porto Allegre	Busway	Assis Brasil	20,000
Sao Paulo	Busway	Santo Amaro	25,000
Sydney	Heavy rail	Carlingford	400
Sydney	Heavy rail	Bankstown	5,700
Sydney	Heavy rail	Bondi junction	6,200
Sydney	Heavy rail	Chatswood	11,900
Sydney	Heavy rail	Parramatta	14,800
Sydney	Heavy rail	Strathfield	28,000
Sydney	Bus lane	Military road	6,700

Sources: URBS (1994), CMTC (1994), ATP (1994), SRA (1994), and discussions with State Transit.

CHAPTER 19

THE IMBALANCE BETWEEN CAR AND PUBLIC TRANSPORT USE IN URBAN AUSTRALIA: WHY DOES IT EXIST?

19.1. INTRODUCTION

A list of the 10 great inventions of the twentieth century is likely to include the internal combustion engine (ICE). The ICE heralded the massive growth in car travel in western societies and bus travel in developing nations. In contrast, we have been witnessing an absolute decline in passenger rail trends (especially after 1990 in CEE, CIS and Baltic countries, but also Western European Countries and the USA) with the exception of Austria and Germany (reported by Thompson of the World Bank, 1996).

In Australia, we are observing a slight upwards trend in the absolute amount of public transport passenger and passenger–kilometre activity, but it is not keeping pace with the increased demand for car travel, resulting in declining market share for public transport (Figs. 19.1 and 19.2). The automobile remains a dominating force in Australia as elsewhere, despite the substantial increase in the cost of motoring. Since 1977 real fuel prices have increased from 14.5 to 74.9 cents/L (in \$1990), which have been only marginally offset by improvements in average fuel efficiency of all cars from 12.59 to 12.1 L/100 km (or 12.95–10.25 L/100 km for new cars). Over the period 1977–1996, where the consumer price index increased 3.5-fold, we have witnessed a 2.25-fold increase in real car prices, a five-fold increase in real fuel prices, a 1.3-fold increase in cars per capita, with vehicle kilometres per car per annum almost unchanged (averaging 15,469 in 1977 and 16,045 in 1997). The delays in travel time have added substantially to car travel costs, yet still the car is preferred for all travel activities. The cost of road congestion in Australian capital cities is estimated by Luk, Hepburn, and Thoresen (1994) to be \$5109 m per annum, with Sydney at \$2,080 m the highest and Darwin at \$24 m the lowest. For Sydney, this is equivalent to \$416 per person per annum.

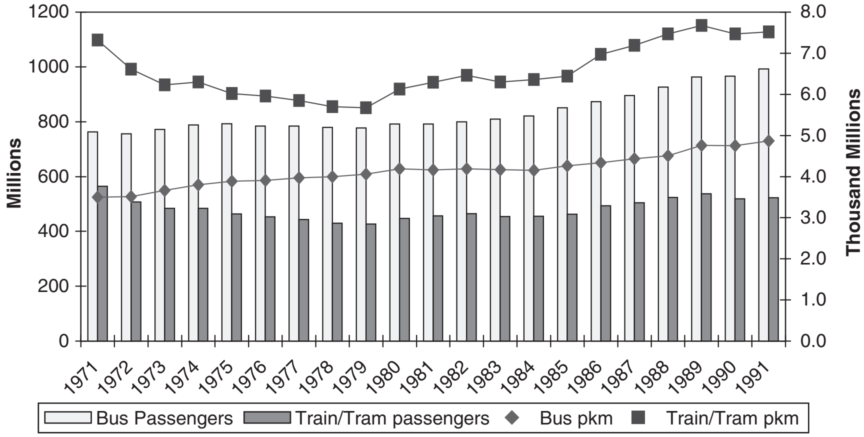


Fig. 19.1. Train and Bus Patronage Shares.

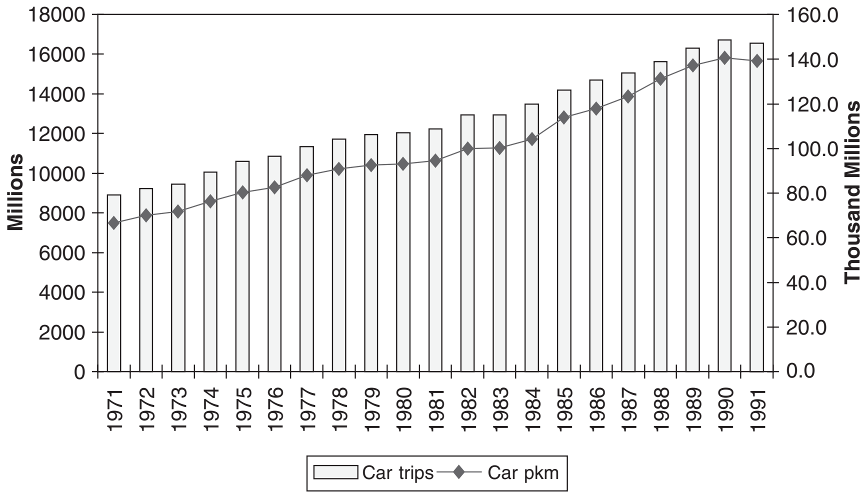


Fig. 19.2. Trend in Car Use.

The demand for car ownership and use is almost insatiable. Planners and politicians struggle to find 'solutions' to the imbalance between the modes; seeking ways of repositioning public transport so that the use of the car is reduced in urban environments where it is performing least effectively.

While we all would like to see greater use of urban public transport – both train and bus – the realities are such that no public transport system within affordable political budgets is ever likely to provide a level of service of sufficient appeal to attract large numbers of car users to switch to public transport across the many travel markets. Public transport has already succeeded in attracting substantial market share where there is a concentration of activity; which in Australia is a rare occurrence. For example, 78% of all commuters to the Sydney CBD daily use trains, buses and ferries – a phenomenally high percentage given the very generous supply of parking and relatively poor road network. The road system itself is the major facilitator of this market, moving many more public transport trips and kilometres than the rail network.

Proponents of public transport increasingly criticise major road infrastructure projects, which do little to assist the move back to public transport. Statements such as 'the traffic will probably just go bang', and the 'city will grind to a halt' if we continue to build more roads and neglect public transport infrastructure typify a view offered in support of an urgent need to stop building major new road links and invest in more rail links. The fact that road space can be allocated to busways is rarely mentioned. Opportunities exist to have significant dedicated bus priority on major freeways, something which is much more difficult to achieve on roads of lesser quality. As a rule of thumb, dedicated busways can deliver a level of service to the community, which has the ability to move either three times the number of passengers for the same cost as the rail system or the same number of travellers for one-third the cost of a rail system.

Thus, one must be careful in *always* assuming that more roads means more cars and more kilometres. Better roads can mean better use of public transport and lower costs of delivering service, if managed properly. The State Transit Authority of NSW claims that increasing average traffic speed from 20 to 40 km/h can reduce bus fleet size from 350 to 180 and reduce operating cost from \$4/km to less than \$2/km (personal communication, Guy Thurston, February 1997). The call to cut car dependency is well intentioned but often not well informed on the real challenges facing the public transport sector.

Induced demand or additional traffic generated by improved road infrastructure is often put forward as a bad result of more freeways. Typically, in metropolitan areas we are talking about 2–3% for major roads, remembering that most of the traffic using the new facilities is diverted from other roads (including buses) and natural growth. Over time some businesses and residents relocate to take advantage of the improved accessibility offered by a specific location, but this is not induced traffic since such traffic already existed elsewhere in the city. One of the great attractions of freeways is that they get traffic off residential streets as well as helping to reduce air pollution from cars previously using roads which involved more stopping and starting due to traffic lights, stop signs and traffic congestion. A very efficient freeway system with tolls would achieve many more savings in environmental costs than are offered by a very poor arterial and subarterial road network unless there was massive switching out of the car to public transport. Almost paradoxically, as we improve our road network to facilitate busways we are also providing improved travel times for car use, and thus making it even more difficult to attract drivers out of their cars. The 'add one lane' approach to busway development may be less appropriate than 'take one car lane away' approach. Unfortunately, the latter is a political minefield.

The recent review by Luk, Rosalion, Brindle, and Chapman (1998) of previous measures in Australia to redress the imbalance between car and public transport in general concludes that all forms of improvements in public transport, and especially rail, do have some impacts on the modal shares but it is quite small and often very localised (see below).

19.2. THE CHALLENGES FACING PUBLIC TRANSPORT

Fig. 19.3 provides a synthesis of some key elements of the changing face of Australian society, which are impacting on the future of urban public transport. These evolutionary changes are also applicable to countries with historically stronger urban public transport such as many Western European countries and Canada, as they are to countries such as Australia and the USA which have run down their public transport in the last 50 years and are now trying to reverse this trend. The key influences on change in the urban passenger transport sector include the changing composition of the labour force and work schedules, the suburbanisation of work opportunities and the accompanying loss of high-density mobility corridors (but an increasing number of low-density corridors suitable for bus systems), the changing incidence of the population in each life cycle stage, the commitment or lack thereof from government to pricing and planning/regulatory reforms, the growing awareness and acceptance of user or beneficiary charges and the greening of the automobile and energy sectors.

Many supporters of public transport often turn to Europe for examples of success. However, the encyclopedic account of tradition and transition in

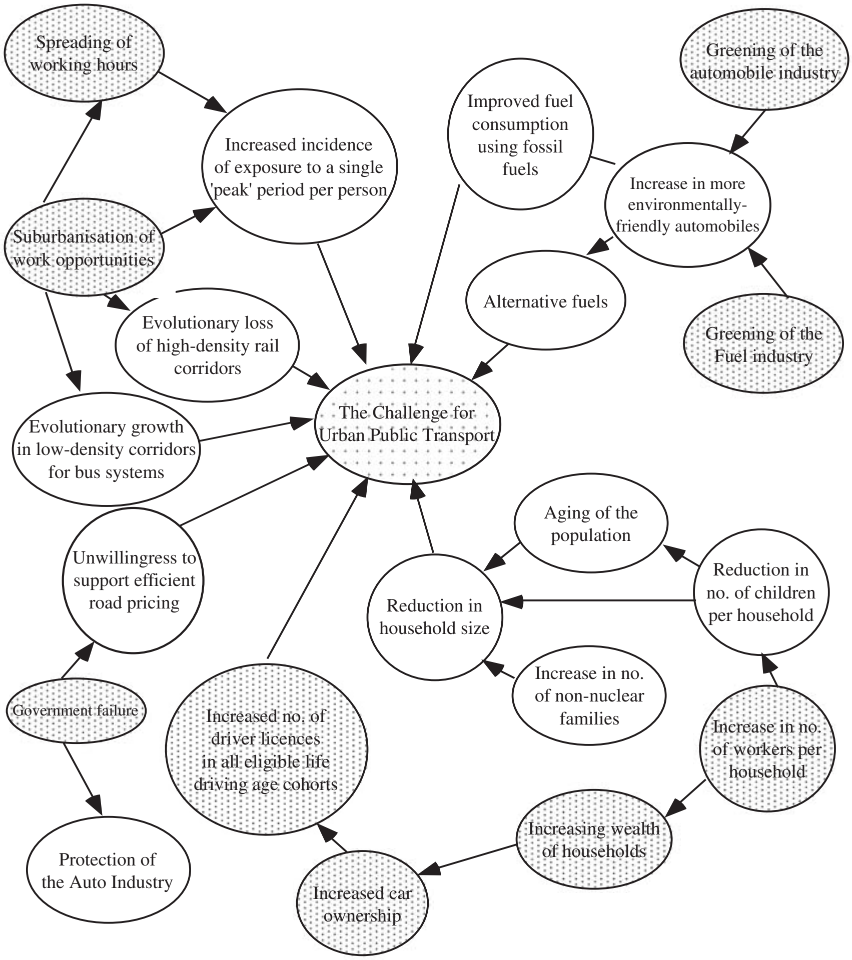


Fig. 19.3. The Challenges for Urban Public Transport.

European travel patterns in Salomon, Bovy, & Orfeuil (1993) portrayed as a ‘billion trips a day’ paints a worrying picture. They show an increasing rate of growth of car ownership (in fact nearly three times that of the USA – Lave, 1992), declining household size, suburbanising residential location and the decline of the central city as the dominating focus of activity. The annual growth rate in personal mobility from 1970 to 1987 associated with private modes in Europe varies from a low of 1.7% in Sweden to a high of 6.8% in

Portugal (with most countries around 3%). The use of urban public transport grew at a negative rate in the UK (−0.9%) and Belgium (−0.4%) and up to 3.6% in Denmark (with most countries between 1 and 2%) (Bovy, Orfeuil, & Zumkeller, 1993). The share of mobility contributed by the private car increased from 79 to 83% during this period. Italy has one of the highest modal splits for urban public transport (26%), with a low of 4.8% in the Netherlands, and a typical percentage share of 11–19% throughout Western Europe.

The story in Australia is also worrying. For example, the 1991 Sydney Travel Survey shows a train share of 3.7% and a bus share of 4.3% for Metropolitan Sydney. There is no evidence to suggest that this has been arrested and reversed in favour of public transport. These downward trends in use of urban public transport are aligned with the reduction in the proportion of all work trips to the central core of major urban areas. These trends are strong and consistent with global evidence that such phenomena occur as the wealth base of the population increases. If one accepts the Newman–Kenworthy density hypothesis, this is not good news for forms of public transport which require high-density traffic corridors to justify both the continuation of existing services, enhancement by new investment and the application of *justified* subsidy based on community service obligation or what might be better referred to as *urban distributive justice*.

19.3. WHAT DOES THIS MEAN FOR PUBLIC TRANSPORT?

With much of Australia's urban environment already in place, the challenge is how to manage better the existing transport infrastructure and any additions at the margin. Success is not only measured in efficient transport networks and environmental protection alone, but also by the effectiveness of processes which involve the community. Better practice recognises the following issues, each of which has a limiting impact on public transport opportunities, especially fixed systems such as heavy and light rail (and even very rigid fixed route timetabled bus systems).

19.3.1. The Role of Transport Systems in the Household Sector in Guiding Changes to the Urban Form is Declining

Today's urban areas are marked by well-developed transport systems. The transport system is likely to have less effective means for shaping urban form in the future because:

- The transport system in most urban areas is highly developed and so the relative impact of even major infrastructure investment will be small.
- The built environment has a very long life; most infrastructure survives 50 years or more.
- Transport while still relevant, is of declining importance in the location decisions of households in particular and to a lesser extent firms. Transport costs make up a relatively small proportion of household expenditures, and increasingly flexible work arrangements are likely to make access to workplaces even less important in the future.
- Information-based firms are 'footloose' as well as making up an increasingly large share of total economic activity. Some sectors of industry such as regional shopping centres and major entertainment complexes, however, remain heavily influenced by major transport investment.

Implication: Transport policy efforts would have to be very extreme to have a significant impact on urban form – it is a blunt instrument in the ranges contemplated given political and economic reality. The corollary is that policies directed to land use (investment incentives, pricing) will be the prime means of changing urban form. However, transport policy, especially that linked to opportunities for public transport, cannot afford to ignore the impact of changes in urban form.

19.3.2. The Urban Area of the Future is likely to Exhibit a Particular Pattern of 'Compactness'

The major cities of Australia are most likely to exhibit physical forms best described as 'cities within cities', with regionalisation occurring throughout the metropolitan area. The most noticeable change is likely to occur at the urban fringe. 'Edge cities' will evolve as regional centres redefining density nodes and providing another point of reference for growth in employment, residential population and economic activity. These nodes are most likely to be of medium density with adjacent low-density activity. The economic and social necessity for more high-density urban form is unlikely to exist. Studies such as the Victorian externalities study and the work in CSIRO (e.g., Roy, Brotchie, & Marquez, 1995) provide supporting evidence for this conclusion. Flexible bus services offer the best public transport service in a setting of low-density activity.

19.3.3. *The Automobile is Becoming 'Greener': Automobile Technology Has a Major Role to Play in Improving Environmental Quality*

Technological innovation linked to automobiles can alone make a significant contribution to containing and reducing local air pollution and greenhouse gas emissions. However, there would be a very significant time lag in bringing the fleet in Australia up to a new standard. Achieving significant improvement in vehicle technology such as fuel efficiency gains and cleaner fuel necessitates mandated minimum corporate average fuel economy (CAFE) legislation as well as minimum corporate fuel type mixes in new vehicle sales. Very large increases in fuel excise may have the same effect, but it is politically more complex and inequitable. In the USA we now see American cars almost as fuel efficient as cars sold in Japan and Europe, despite the much lower petrol prices. Such enhancements reduce the strength of the argument in favour of public transport as more environmentally friendly; although at present the argument holds strong.

19.3.4. *Pricing Will Need to be Further Promoted to Complement Technology Improvements*

To ensure that the level of total vehicle use is sustainable, the introduction of more severe pricing through a general fuel excise, congestion pricing and parking pricing may be required. An appeal of pricing is that it generates useful revenue which can be disbursed fairly to (a) improve road space; (b) give priority to users of roads who have economic or other precedence (e.g., high occupancy vehicles, freight vehicles); (c) to improve non-road-based public transport; and (d) if less road space is required to satisfy (a) and (b) then an enhanced environment (e.g., more open space). It is also the way towards balancing the supply of road space with demand, for an economically and financially sensible outcome.

A mix of pricing and non-pricing policy tools provides a realistic way ahead, with the use of targets as a practical means of securing progress in respect of compliance with the goals of urban management. Pricing is one of a number of policy instruments, which has a role in meeting targets such as a percentage reduction in greenhouse gases, percentage improvement in corporate average fuel efficiency and absolute reduction in local air pollution; and the flow onto increased public transport share. It is inherently unlikely that any one tool alone will be as effective as complementary tools in combination. Sadly, political processes baulk at suggestions to use pricing to allocate scarce resources more efficiently and equitably. Singapore once again is to lead the 'charge' with fully integrated electronic road pricing within the central area and its approaches.

19.3.5. Work Practices Can Have a Significant Influence on Total Travel by Time and Place

Flexible work practices both in space and time (e.g., telecommuting, compressed work weeks) are very promising ways of reducing the amount of travel associated with work trips, but do increase the possibility of some people living further away from their jobs and more non-work travel activity. However these instruments spread the traffic in space and time, improving the utilisation of existing road capacity (in particular) and reducing or delaying the need for more road and rail capacity.

19.3.6. Do Not Forget the Growing Importance of Business and Non-Commuting Travel Activity in Shaping Our Cities

Strategies for reducing vehicle kilometres should reconsider the predominant interest in commuting activity and give more emphasis to business and non-commuting travel as vehicle kilometres in this class of travel increase. More than 50% of the peak passenger traffic in Sydney is non-commuting. The Australian Road Research Board has calculated the vehicle operating cost resources consumed in the Australian road transport sector in 1991 and found that out of a total of $37.8 billion spent in cities, $12.9 billion is spent in business travel by car, $5.5 billion in business travel by light commercial truck. This represents the single largest category of road travel expenditure, considerably larger than the traditional commuting trip to affixed destination. With this market being almost totally dependent on the use of the automobile, the gains to the environment from studying ways of making the automobile more sustainable in this market is a high priority. Public transport is unlikely to serve this market.

19.3.7. The Air We Breathe in Urban Australia is Not So Bad

The air quality of Australian cities tends to be relatively unpolluted compared with cities in the United States and Europe. There is currently no evidence that fine particles are above safe levels. The pollutants No_x, CO and SO_2 do not currently and are not expected, within the foreseeable future, to exceed acceptable levels. There is, however, always room for improvement and efforts must continue to seek out an even higher quality for the air that we breathe. The major contributing chemicals to local air pollution, while still present, are being reduced significantly as a result of a mix of improved vehicle technology and inspection procedures. Concentrations of most air pollutants are now at 'acceptable levels', for which the evidence indicates no health risk, although there may be localised extreme problems at times. Carbon dioxide, the major source of greenhouse gas emissions is still on the rise, however. Travel demand management strategies involving financial disincentives are essential if total automobile use is to be contained to sustainable levels. It appears that there is more success in cleaning up the environment via improvements to vehicle technology and the rearrangement of patterns and timing of travel than a significant switch to public transport.

19.3.8. Much of Our Urban Environment Exists and Adaptation Will Be a Long Drawn-Out Process

Integrated strategies can make a difference, but outcomes will be incremental and often slow to take effect, especially at the regional level. Key issues at the regional level are how to adapt urban regions to provide for growth and change while moving towards more sustainable and equitable cities. Key issues at the local level are how to create precincts, particularly in established areas, with a higher degree of environmental protection than they have at present. Key issues at the traffic route level are how to ensure that corridors for movement are protected while preserving the needs of adjoining owner and occupiers and adjacent communities. The potential for bus and light rail is high in each class of spatial planning.

19.3.9. Isolating Freeways and Tollroads to Assess Their Net Contribution is Very Misleading

One of the major reasons for freeways is to eliminate much traffic from local streets and subarterial roads in order to make our road system safer for drivers, passengers, pedestrians and local residents – both households and firms. The idea of freeways as traffic corridors so that activity precincts can be made safer, quieter and more pleasant is a very real reason for their existence. Much of the traffic using freeways is diverted from the existing road network, with a maximum of 2–5% generated by the road investment. The benefits of freeways when seen in this broader network context more than outweigh the costs of their provision, including social and environmental costs. Well-defined road corridors open up opportunities for serious busway systems (with suburban connectors) and truck routes. The UK government has recently proposed such dedicated traffic be promoted in future freeway expansion.

It is now well recognised that the evaluation of infrastructure needs must be undertaken within a framework which emphasises the full set of social costs and benefits in terms of the primary goals of urban management – economic growth/efficiency, equity/social sustainability and environmental sustainability. Murphy and Delucchi (1998) review the evidence on the social and environmental costs of car use and find that the external costs (i.e., congestion, noise, accidents, building damage, air pollution, water pollution) can be as high as 50% of the full costs of car travel. Positioning the financing decision within this setting will encourage a more balanced assessment of alternative ways of satisfying these broad goals, of which non-infrastructure solutions must compete alongside of infrastructure projects.

19.3.10. Much Progress Has Been Made in Making the Road Environment Safer

Regulatory actions in recent years have yielded significant benefits in terms of improvements in the accident rate. Improvements in vehicle safety, road user education (especially advertising linked to seat belts, drink-driving and cyclist helmets), black spot and safety audit programmes have all been positive initiatives. Public transport offers the best safety profile of all land modes (Figs. 19.4 and 19.5).

19.3.11. Flexible Public Transport Needs More Serious Consideration

There are many ways of providing improved public transport – heavy and light rail, bus systems, fixed route buses, hail-n-ride buses, taxis, etc. Greater flexible public transport is required to serve deep into suburbia if we are to see any noticeable increase in the market share for public transport. Roads are used by public transport; indeed they are arguably the most flexible form of infrastructure in accommodating mass public transport, and are capable of assisting public transport in adapting to changing levels of traffic density for relatively low cost. Furthermore, the road-based public transport system can cater best for the many diverse transport needs of people with

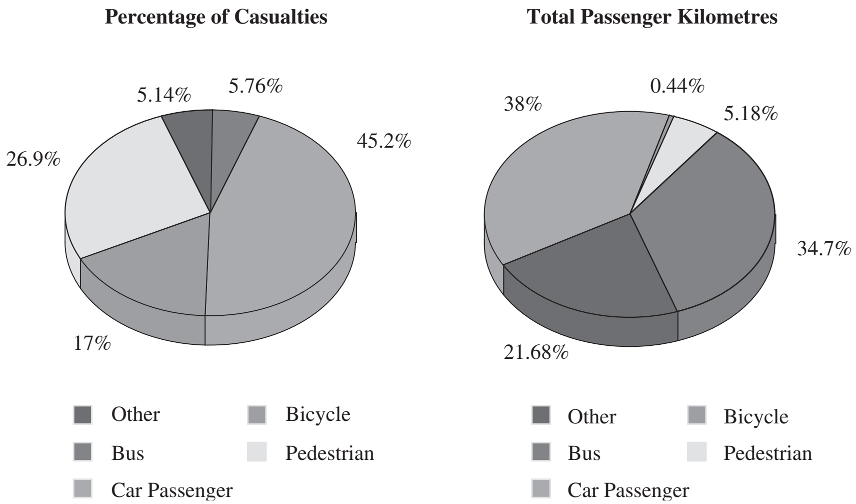


Fig. 19.4. Profile of Casualties and Passenger Kilometres by Mode in Urban Australia.

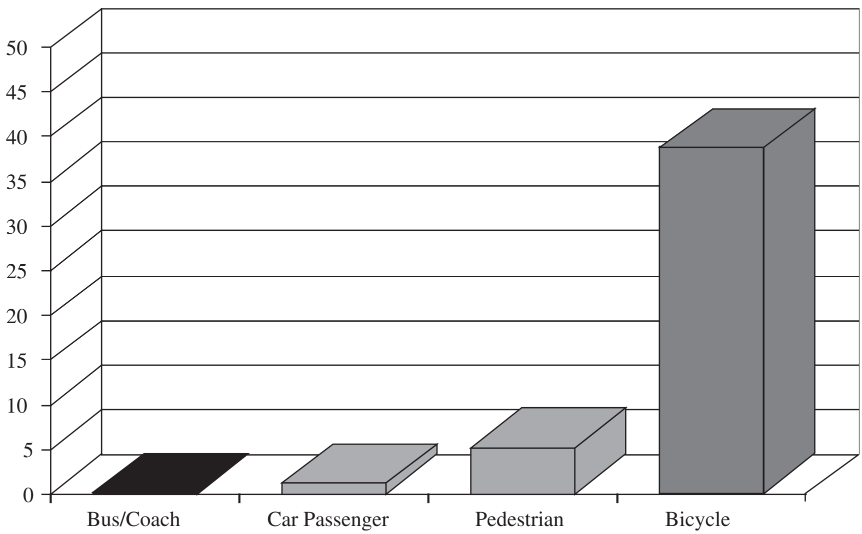


Fig. 19.5. Risk Exposure Indicator by Mode.

disabilities, ranging from scheduled buses designed with low floors and wheelchair access to specialised taxis and community transport buses. A challenge for urban society is to find appropriate roles for bus and rail systems. Busway or rail systems for their own sake – the means paradigm – is not a rational way of determining compatibility with the overall goals of urban management. Remember that the road system provides the infrastructure to carry more public transport users than the rail system.

19.4. LOOKING FOR NICHES: NOW YOU ARE TALKING SENSE

Why do we continue to subsidise *all* urban public transport users so that we can transfer benefits to the subpopulation who create the need for a community service obligation (CSO)? Or is a CSO a reflection of a broader obligation, which has arisen through government failure to assist the market to operate under efficient *social* prices on all competing modes (i.e., competitive neutrality) and to include these efficient prices in an investment appraisal which might guide the selection of price-efficient passenger transport investments? This is not an easy set of questions to answer. The position here is that until market efficiency of the first best type is permissible the second-best competitive efficiency pricing regime is used to justify low public transport fares. Consequently, we have a mixing of inefficiency and redistributive injustice in our fare structures. For urban public transport, fares as an instrument used to attract or maintain patronage has little impact, and so low fares are a formula for 'throwing good money away'.

The international evidence tells us repeatedly that individuals most likely to use urban public transport are:

- school children,
- households with low household incomes (but not necessarily low personal incomes for multi-worker households),
- a declining proportion of the elderly (those without drivers licences or who are physically unable to drive and who have limited access to support networks which provide private or community car-based transport),
- those who have no automobile available in the household,
- people who live in a central city and work in or adjacent to the central business district, and who live in a densely settled area, and
- urban tourists (mainly central city services).

In the context of the commuting trip, workers satisfying these criteria typically exhibit a public transport use in excess of 70% in many cities. Such workers however are a declining percentage of the workforce. For example, in the USA they are 4.7% of all commuters in 1980 and even less today. In Western Europe, in large cities such as Paris we find that the share of commuters living in/near and working in the central city is 17% and declining, with massive growth of commuting from persons living and working in the suburbs – 48% of commuters in 1982 (Jansen, 1993).

Pushkarev and Zupan (1977), a much cited book by proponents of rail systems state on pages 172–173 that "… from the transit viewpoint, it [would be] much more 'profitable' to gain riders either from restraints on automobile use or from increased density of urban development". Wachs (1993) argues that while traffic reduction by urban density increases has become increasingly popular among environmentalists and urban reformers, many scholars have demonstrated that low-density development patterns do not necessarily result in heavier traffic congestion. There is little empirical evidence which persuades many that this approach is fundamentally sound. Authors such as Newman and Kenworthy 'demonstrate' that higher density cities generate fewer trips and lower energy consumption per capita than lower density cities. They show this by comparing different cities at one point in time at various stages in their historical development rather than tracking particular cities over decades. This runs into the problem of ecological correlation or spurious causality. An ecological fallacy is the product of falsely inferring that what is true of different ecologies or groups (i.e., a comparison of cities at a point in time) is true of individuals (i.e., a city over time):

> [In Newman and Kenworthy] … Los Angeles is compared with Hong Kong or New York in order to reach the conclusion that density can make the intended difference, but there is no guarantee that the adoption of Hong Kong or New York style densities [any more than Singapore's car quota system] would result in the intended outcome. In fact, most of the high density cities which are cited as examples were major metropolises long before the coming of the automobile, and over time they are becoming less dense as lower density suburbs are added at their peripheries and as higher rates of automobile ownership occur in these cities in response to rising incomes. (Wachs, 1993, p. 348)

Two of public transport's most natural markets, relatively low-income inner-city residents and high-income commuters accessing medium-to-high density corridors leading to the central business district need niche treatment. Expanding public transport rail services far into suburban areas in contexts where we are loosing the dense corridors linked to a major destination is precisely what has the least market potential. Improving bus services however may have a more appealing role. Investing in new rail systems as *an isolated strategy* is a very expensive way of attacking the general problem. The results where this has been undertaken in urban areas with a dominating automobility have been disappointing – low ridership, and debilitating subsidies (Hensher & Waters, 1994).

The Blue Line in Los Angeles is indicative of an outcome. The Blue Line has a taxpayer cost of $US21 per rider per day. Since few of its riders are former drivers (as opposed to bus users), the system costs taxpayers $US37,489 per year for every car it currently removes from the freeways. A comparison of the life cycle costs of providing bus services compared to light rail in Los Angeles (using the construction and budgeted operating costs of the LRT Blue Line) leads to a conclusion that for the same level of funding, Los Angeles can either afford to build and operate the Blue Line for 30 years or operate 430 buses for 33 years, including the cost of building the operating divisions to support these new buses. For the same cost, however, the buses would produce over four-and-one-half times as many passenger kilometres and carry over nine times as many passengers (Rubin, 1991). This result is reached even though the assumptions made tended to favour the Blue Line on several important issues. Buses, especially bus priority systems are better value for money and if designed properly can have the essential characteristicity of permanence and visibility claimed to be important to attract property development along the route which is compatible with medium-to-high density corridor mobility.

The NSTS in Perth, which opened in 1992 attracted both previous car and bus users, with 64% of its patronage coming from bus. When the impact of road traffic is calculated, we find that the vehicle volumes per week day have dropped by less than 2,800 vehicles out of a total of 100,000, or 2.8% (Luk et al., 1998). This is very small indeed and raises questions about the value of an expensive heavy rail system that impacts significantly on a bus system and little on car demand. A dedicated busway on the existing expressway may have been a better proposition? The Gold Coast railway is another example of a failed effort to attract drivers out of their car – its primary source of patronage is ex-bus travellers. Is this really the way to redress the imbalance?

19.5. THE BRITISH CHALLENGE TO TRY AND REDRESS THE IMBALANCE

Efforts to attack the domain of the car continue unabated. Interestingly, in the UK (and often in the USA) the emphasis has been placed on the single occupant car trip with incentives to encourage ride sharing by car rather than moves to use traditional public transport.

The journey to work has again been targeted for closer attention, since it is seen as a key area to be tackled in order to achieve sustainable transport. Commuter car trips push highway capacity to its critical limit, while providing for high-volume peak direction flows better suited in theory to public transport. The increasing dispersal of workplaces away from traditional city centres has changed things. Preparing green commuter plans is seen as a way forward for major employers, through specific incentives for commuting by bike, car pooling and bus. Incentives include organising car-sharing and car-pooling schemes, installing changing rooms and showers for cyclists and squeezing car parking provision to force the more persistent drivers out of their beloved vehicles.

There is a concern that these incentives will have limited long-term effect if a substantial number of firms do not follow suit, and if senior staff do not lead by example. Employer tax concessions on investment in facilities to support non-drive-alone commuting are being suggested. While this is all to be applauded, the success in the USA along similar lines can hardly be described as notable. Employer-incentive schemes have generally failed to achieve any noticeable impact on road traffic.

19.6. TAKING A CLOSER LOOK AT LIGHT RAIL OR TRAMS

> A Return to the Past or a Genuine advance in Technological-led improved Accessibility?
>
> Yet another male politician, Alliance's list MP Grant Dillon, comes out in favour of light rail as the panacea to Auckland's transport problems, overlooking the fact that a lot of relatively cheaper bus lanes are failing to eventuate, due to cost. Buses are, therefore, neither as full nor frequent as they should be in a city of over 1 million people. I wonder if these men have ever given up playing with their Meccano sets? Jan O'Connor, Takapuna, letters to the editor, New Zealand Herald, March 7, 1997.

Sydney (and other cities in Australia) has emotionally embraced the old idea of inflexible public transport with the return to Sydney's streets of steel-on-steel light rail. We are now seeing the mingling of trams with cars and buses as our street system struggles to cope with yet another form of old public transport which competes with walking and buses far more than it is likely to attract individuals out of their beloved cars. With such generous parking facilities in and near the Central City and at such reasonable prices (early bird specials of $6 per day), this increased accessibility offered by more public transport technology is unlikely to do much more than provide an interesting tourist attraction and satisfy the needs of those who believe in trains as the only form of public transport.

The light rail system currently between Ultimo and Pyrmont is a joint venture between government and private sector (in the sense of risk sharing); and is promoted as the beginning of the revival of the city as a residential precinct. The new Sydney Casino is expected to be a major traffic generator. Indeed, so important was the Casino in early discussions with Government that a risk provision in the privatisation contract stated that "If the permanent Casino opens for trading more than 12 months after the light-rail is completed, or after 31 March 1998 if this is a later date, the Department of Transport will be liable to pay the Pyrmont Light Rail Company $8,219 per day until the Casino opens". As on late February 1998, the patronage levels are well below forecasts with a peak in the very early hours of the morning as casino clients go home.

Strong views exist on the merits of light rail as a preferred alternative to dedicated busway systems. Why did we not consider having a very flexible bus system on the dedicated alignment, which has the capability of offering much better door-to-door service than a very inflexible fixed rail system? The answers are relatively simple – the adage that 'trains are sexy and buses are boring' (quoted from the Mayor of Los Angeles) says it all. I have previously described this as 'choice versus blind commitment' (Hensher & Waters, 1994). When the evidence suggests that one can move three times as many people by dedicated busway systems for the same cost or the same number of people for one-third of the cost as light rail, one wonders about the rationality of urban planning. Wentworth (1997) concludes from a review of the proposal to extend the light rail system between Central Railway and Circular Quay, that a re-designed bus system would provide a better immediate result at a much reduced cost. He asks "… perhaps the investors themselves may have been taken for a ride by professional promoters … Or is it just an innocent mistake? The only thing clear is that there is something fishy about the whole affair".

What about the future for bus systems? The experience of these operators in Curitiba, Porto Allegre and Sao Paulo supports the contention that, under appropriate regulation, organisation and capital investment, bus-based transit systems are capable of transporting large volumes of passengers at reasonable speeds for minimal capital and operational costs. Table 19.1 illustrates this capacity (also see Chapter 18) by a comparison of

Table 19.1. Volume of Passengers Using Transport Corridors in the Peak Direction of Travel during the Peak Hour.

City	Mode	Line	Pax/h
Curitiba	Busway	Pinheirinho	11,000
Porto Allegre	Busway	Assis Brasil	20,000
Sao Paulo	Busway	Santo Amaro	25,000
Sydney	Heavy Rail	Carlingford	400
Sydney	Heavy Rail	Bankstown	5,700
Sydney	Heavy Rail	Bondi Junction	6,200
Sydney	Heavy Rail	Chatswood	11,900
Sydney	Heavy Rail	Parramatta	14,800
Sydney	Heavy Rail	Strathfield	28,000
Sydney	Bus Lane	Military Road	6,700

Source: Smith and Hensher (1998).

the volumes achieved by busways in these cities with a number of heavy rail corridors in the Sydney metropolitan region.

Busways only function as efficient high-volume transport corridors where the operations are adapted from traditional bus practice and where substantial infrastructure investments are made in bus stops, terminals and vehicle types. Certain advantages of busways over rail-based systems (such as the avoidance of transfers at terminals; the use of standard equipment) may correlate negatively with the capacity the busway can achieve. Certainly, the most successful high-volume busways in Brazil require both passenger transfer and specialised equipment. On the other hand, where busway systems are based merely on providing road space for operators to utilise (as in Porto Allegre), this results in low operating speeds and productivity.

Although previous research has suggested that busways on the Porto Allegre model could efficiently transport 39,000 passengers/hour (Cornwell & Cracknell, 1990), operating experience in Brazil does not confirm this figure. The current maximum volume carried on an efficient busway (i.e., with an average speed greater than 20 km/h) is 11,000 pax/h in Curitiba, and where volumes exceed this, the average bus speed drops towards that of the surrounding traffic flow. It remains to be seen whether the Curitiba 'surface subway' and the proposed systems in Sao Paulo will be capable of both moving 22,000 pax/h volume and maintaining average speeds in excess of 25 km/h, as predicted.

Nevertheless, the existing busways can provide an equivalent capacity to an LRV system, at a fraction of the capital costs. As Cornwell and Cracknell concluded:

> The capacity of a well designed and efficiently managed busway can be equivalent to that of an LRT, on a comparable basis (for example, degree of segregation; stop spacing). (Cornwell & Cracknell, 1990, p. 195)

and that

> … it should be noted that despite the current wave of LRT proposals, and the considerable resources which have been invested in various LRTs (Manila, Hong Kong, Rio de Janeiro, etc.), the consultants know of no LRT in a less-developed country which outperforms the busways surveyed in terms of productivity (passenger volumes × speeds). (Cornwell & Cracknell, 1990, p. 200)

In interpreting comparisons between LRV and busway systems, it is important to note the contrast between 'theoretical' capacity and capacity achieved.

The Brazilian experience also supports the key interrelationships that exist between successful busway operation and long-term planning, land use, appropriate regulation and political stability. Where busways have been implemented in isolation from coherent planning and land-use strategies, the results have been either partial, inefficient systems (as in Sao Paulo) or overcrowded systems that cannot adequately meet demand (Porto Allegre and Sao Paulo). The outstanding feature of Curitiba is that an integrated system of bus service types has developed in response to a clear and structured urban plan. This combination of a planning-driven 'bus-friendly' urban form and a marketing-driven, innovative bus operation has provided Curitiba with an excellent transport system. The busways are no more than an important element in this process.

Furthermore, the contrast between Curitiba and Sao Paulo is not so much in the preparation of plans, but in their consistent implementation over a 30-year time frame. Political stability has enabled the planning and innovation in Curitiba to deliver results. Similarly, the effective of busways is also dependent on an integrated regulatory regime. The decline in the effectiveness of the Porto Allegre busways results from the removal of the 'umbrella' regulation of EBTU. Although the multiple operators have effectively developed a system-wide fare system, they have not been able to maintain the efficiencies of the busways. Similarly, a major restraint on the Santo Amaro busway in Sao Paulo is the presence of 'pirate' bus operators, who overload the capacity. An efficient busway requires a firm and coherent system of regulation (Table 19.2).

The busway systems in Curitiba, Porto Allegre and Sao Paulo provide an illustration of the strengths and weaknesses of this transport mode. Although these systems have operating weaknesses, and although many aspects of their operation are not transferable to other national contexts, they

Table 19.2. CMTC Busways in Sao Paulo – 1994.

	Paes de Barros	Santo Amaro Avenue 9 de Julho	Vila Nova Cachoeinha
Year of opening	1980	1987	1991
Type of bus	Trolley	Trolley and diesel	Diesel
Length	3.4 km	14.6 km[a]	11.0 km[b]
Terminals	1	1	2
Overtaking lanes	No	Yes	No
Busway Rtes[c]	6	27	14
Number of buses	61	372	159
Buses/peak hour	30	250[d]	75
Pax capacity/hour	3,000	25,000	8,250
Peak hour operating speed	N/A	AM: 21.0 km/h PM: 11.2 km/h	AM: 23.0 km/h PM: 16.0 km/h

Sources: SMT (1993a, 1993b).
[a]Of the 14.6 km, only 11.0 km is exclusive bus roadway.
[b]Of the 11.0 km, only 5.5 km is exclusive bus roadway.
[c]Includes both trunk routes (using the corridor) and associated feeder routes.
[d]In addition, up to 50 illegal buses use this corridor per hour.

nevertheless provide working examples of the capacity of the bus to provide cheap and efficient solutions to major urban transport problems.

19.7. CONCLUDING THOUGHTS: THE KEY CHALLENGES REMAIN

The objective of this chapter is to establish a series of positions in relation to the role of urban public transport in a setting which will increasingly see more emphasis placed on the social and environmental impact of all modes. The main points of the debate, summarised below, contain a number of very deep meanings for the future of urban public transport.

19.7.1. Some of the Main Points to Debate are:

- The crucial issue missing in the current debate on the future of urban public transport is the future of the automobile in the context of alternative regimes of pricing and physical planning signals. Without this context, the whole debate is lopsided and unproductive. Without a major effort to make the car less attractive, the *economic* future of public transport (especially rail), in the absence of massive public subsidy, does not look good. The value of *subsidised* public transport for all, for the common good of the environment may be a fallacy.

- In the absence of a cost-related pricing strategy for all means of passenger transport, net immigration in urban areas will be a major factor in determining the levels of congestion both on our roads and within public transport (especially rail services).
- All forms of transportation infrastructure and services are potential candidates for improvement. However, they must be evaluated in a context of cost-related pricing (accommodating the fuller set of costs such as environmental pollution, both chemical and visual). Market forces are a very powerful feature of the process – the challenge is to establish appropriate pricing signals such that consumer preferences for transport and location result in choices being made, which are socially and environmentally acceptable outcomes.
- The establishment of appropriate (social) prices will, within a society of significant variations in individual wealth, produce a continuum of land use/travel bundles, accommodating the preferences of individuals for high-density/low travel requirements through to low-density/high travel requirements. Low-density/low travel requirements can also be included in the set, as exemplified by the decentralisation of workplaces and opportunities to reduce the commuting time while choosing a low-density residential location. The statement "I'll have mine medium rural please" should sit comfortable next to "I'll have mine well-done central please"!
- The move to suburbanise residential and employment activities has tended to reduce average trip distances, and to increase average trip travel times. The increase in trip times, however, is also a result of under-priced and consequently inadequate capacity, in part reflecting a lack of resources to finance new investment.
- The introduction of road congestion pricing, *if* it is expected to modally shift substantial amounts of traffic, must be accompanied by advanced planning for rail capacity expansion. Otherwise the congestion on the roads will be transferred to the rail network, the latter already exhibiting high levels of within-train congestion in peak periods.
- Planning for the full spectrum of urban densities reflecting efficient social prices for land use and travel (i.e., a full set of spatial bundling choices) will assist in making public transport economically more attractive but not dominating the automobile except in selective market segments.
- A fatal flaw in some of the contemporary debate on the future of our cities may be that healthy and vibrant cities should have a central core, which

is alive 24 h a day. The brooding over downtown's *relative* demise and to plan big to revive it may have little correlation with the virtues of a socially and environmentally preferable future and may lead to over-investment in public transport in the wrong places. This perspective does not detract from the trend for some movement back to the Central city by younger people living in apartments.

- One should be cautious about downtown and public transport promoters who have chosen to depend upon the downtown 'solution' rather than consider the merits of the arguments that fixed-rail alone cannot compete with efficiently priced and well-managed automobile transport, sound bus systems and supplementary transit schemes like dedicated busways, transit lanes and super expresses. Some years ago Melvin Webber predicted that BART in San Francisco "may become the first of a series of multi-billion-dollar mistakes scattered from one end of the continent to the other" (Webber, 1979, p. 132). We must be wary of the view that a rail system is by definition a transport of delight, a symbol of progress at which all can marvel, whatever the reality of its actual performance in enhancing social mobility, alleviating congestion or reducing pollution (Richmond, 1991).

19.7.2. A Final Word: 'Horses for Courses' in the Reform of Public Transport

The challenge – to introduce the full set of 'right price signals' – so that individuals can respond in ways that ensure the best social and environmental outcome, and governments, in particular, are then placed in a financial position to respond appropriately with new transport investment and appropriate physical planning incentives. All forms of transport should be party to these developments.

For all public transport – heavy rail, light rail, busway and buses – to have a non-marginal increase in market share, governments and the private sector will have to commit themselves to massive increases in rail and road infrastructure (the latter dedicated to busways) which connect a significant number of 'almost door-to-door' locations. This requires billions of dollars of finance, and will only be forthcoming with road pricing accompanied by some rule of allocation back to transport in general and public transport in particular. Without this, we are destined to a life of 'marginal activity within public transport' and continual dominance of the car. The adage "we will only make public transport more attractive when we make car use less attractive" is a real today as it has been for many years.

APPENDIX 19A. URBAN PASSENGER TRAVEL ACTIVITY IN AUSTRALIA

Year	Bus Passengers (Millions)	Bus Passenger Kilometre (Thousand Million)	Train/Tram Passengers (Millions)	Train/Tram Passenger Kilometre (Thousand Million)	Car Trips (Millions)	Car Passenger Kilometre (Thousand Million)	Truck Tonne Kilometres (Thousand Million)
1971	763	3.5	565	7.32	8,912	66.5	9.14
1972	756	3.51	508	6.61	9,217	69.9	9.69
1973	772	3.66	484	6.23	9,456	71.8	10.27
1974	788	3.8	484	6.30	10,049	76.3	11.05
1975	793	3.89	464	6.02	10,594	80.4	12.75
1976	784	3.91	453	5.96	10,863	82.5	13.64
1977	784	3.97	443	5.85	11,340	87.9	14.43
1978	779	4	430	5.70	11,729	90.9	15.95
1979	777	4.06	427	5.67	11,935	92.5	17.37
1980	791	4.19	447	6.13	12,057	93.1	18.41
1981	791	4.16	457	6.29	12,232	94.5	19.88
1982	800	4.19	465	6.46	12,936	99.9	20.80

APPENDIX 19A. (*Continued*)

Year	Bus Passengers (Millions)	Bus Passenger Kilometre (Thousand Million)	Train/Tram Passengers (Millions)	Train/Tram Passenger Kilometre (Thousand Million)	Car Trips (Millions)	Car Passenger Kilometre (Thousand Million)	Truck Tonne Kilometres (Thousand Million)
1983	810	4.17	454	6.30	12,953	100.1	21.87
1984	821	4.15	455	6.36	13,483	104.2	24.23
1985	851	4.26	463	6.44	14,198	113.9	25.41
1986	873	4.34	493	6.97	14,703	117.8	27.15
1987	896	4.43	505	7.19	15,053	123.3	29.28
1988	926	4.51	524	7.47	15,621	131.3	31.82
1989	963	4.66	537	7.67	16,318	134.5	33.50
1990	966	4.55	519	7.47	16,717	136.3	34.08
1991	993	4.62	523	7.52	16,553	133.7	34.08
1982		4.96		7.52		134.5	
1983		4.72		7.18		137.5	
1984							
1985							
1996							

Source: Cosgrove and Gargett up to 1991(1992).

CHAPTER 20

URBAN PUBLIC TRANSPORT DELIVERY IN AUSTRALIA: ISSUES AND CHALLENGES IN RETAINING AND GROWING PATRONAGE

20.1. INTRODUCTION

Bus and train patronage is increasing in absolute numbers in all Australian cities. However, its contribution to modal share is declining. For example in Sydney, over the period 1981–1997/1999 the modal share for bus and train (based on non-walk modes and linked trips) declined from 12.5% in 1981/1982 to 10.3% in 1991/1992 and 9.75% in 1997/1999.[156] The trend represents an annual absolute share loss of 0.175-percentage points. If the trend continues, we lose nearly 2% annually of bus and train linked trips to other modes (mainly car).

Although reversing this trend and growing the market is a highly desirable aim, it might be difficult to add substantial market share and total activity where the car is so dominant (Hensher, 1998a) and where massive financial outlays would be necessary to show non-marginal changes in share. As an example, using the Institute of Transport Studies, Transport and Environmental Strategy Impact Simulator (TRESIS), Hensher (2002, Chapter 11) evaluated the likely gains in commuter bus share from a large number of policy changes. Focusing on the instruments commonly available to public transport operators (e.g., fares, service frequency, travel times) and the provision of transitway systems, a number of scenarios were evaluated that have stretched fare and service levels about as far as is politically and commercially feasible (certainly in Australia). Indeed, some changes are beyond likely policy activity, such as a 40% reduction in fares and a 40% decrease in access time and in-vehicle travel time (the latter requiring a massive increase in network coverage).

1. Bus fare (decrease by 40 and 20% and increase by 20 and 40%).
2. Bus frequency (doubled and halved).
3. Access time (decrease by 40 and 20% and increase by 20 and 40%).
4. Bus in-vehicle time (decrease by 40 and 20% and 20 and 40%).
5. A new busway system in Sydney between Liverpool and Parramatta.

For each policy, we evaluated a number of incremental intensity levels.[157] The impacts are evaluated year-by-year over a 10-year evaluation period of 2001–2010. The evidence for Sydney suggests that even with the most draconian policies such as a 40% fare decrease, the commuter modal share for bus increases from 10.47 to 13.08% (an absolute increase of 2.61%). While this represents a 24% growth in the bus share (which in itself is impressive), its impact overall on car modal share is very small (from 72.54 to 71.05% for car), a 2% decline. Part of the explanation lies in the fact that changes in the generalised cost of travel (based on the cost and time components of a trip and other attributes of the service) have a 'corner solution' impact in most markets due to the presence of cars in households. Another way of saying this is that, unless a change in generalised cost of car travel[158] is sufficient to lead to the disposal of a car, the overall modal share is unlikely to be affected to a great extent. This is particularly notable in trip locations involving outer suburb to outer suburb travel.

The potential to grow the bus patronage market through traditional public transport policy instruments applied across the board (based on the evidence above) might best be described as bleak.[159] Although this aggregate evidence is disturbing, there are many (niche) success stories where patronage has been captured through innovative efforts by operators,[160] or in some cases by simply benefiting from a growing population base without any initiatives by the service provider. What (niche) opportunities are there for growing bus and train patronage? This is clearly the big question that must be investigated. It requires recognition of the role of incentives delivered through the market and/or the institutional context within which operators service the passenger market. Examples where the market has provided incentives (that were recognised) include introducing many more limited-stop services on a medium to high-density corridor (e.g., the M2 tollroad in Sydney, the cross-regional Hills City service (Harris Park bus service)) from the Carlingford area in Sydney to the City, Special Events such as the Easter show and major sports functions, and orbital services around the perimeter of an entire metropolitan area as in Perth (WA) involving a strategic alliance between three operators who service the contract areas through which the service is provided.[161]

These examples of niche opportunities are often multi-functional,[162] serving a variety of purposes but nevertheless not the usual types of public transport variations one commonly sees through timetable tinkering. The role of incentive-based mechanisms for growing the market that can be delivered through the regulatory process (e.g., competitive tendering, performance-based contracts) have been presented elsewhere (Hensher & Houghton, 2003; Hensher & Stanley, 2003). In this paper we focus on the reality of the market and the range of initiatives that have potential to deliver patronage growth. We draw on global experiences that are relevant for the Australian environment, mindful of the cost of implementation. At the outset, we strongly subscribe to the view that urban public transport is predominantly a provider of services to (ever changing) niche markets. Identifying the what, where and size of these markets is the big challenge.

The chapter begins with an overview of some big themes and key sentiments and then positions the themes within a framework that reminds us of the mindset that works best in focusing on real (in contrast to 'mind-dream') opportunities. Key practices and public policies are then highlighted that offer real opportunities to grow public transport patronage. This leads naturally into a discussion of best practice public transport guidelines that act as useful benchmarks against which to 'test' new initiatives. Specific issues such as rethinking stereotypical segments of potential public transport users, individualised marketing of services (the embodiment of the door-to-door sales strategy) and the blind commitment to specific technological 'solutions' are addressed. The chapter concludes with a suggested framework within which all public transport initiatives might be assessed.

20.2. BIG THEMES AND KEY SENTIMENTS

Why should we be concerned about the loss of market share by public transport? If private goods arguments are appropriate, then like any business that looses ground to its competitors, it will continue to serve the market all the while it is able (or wishes) to. However, public transport is not usually regarded as a private good but a public or quasi-public good whose value is measured by its benefits to society above those normally delivered by private goods. The public goods arguments include the merit argument that all individuals are entitled to a minimum level of transport service (the accessibility argument), and the externality argument in that public transport offers a viable alternative to transport modes that impose greater negative externalities on communities in the form of traffic congestion, air pollution, greenhouse gas emissions, accidents, etc.

Securing the provision of public transport, however, usually comes at a very high financial cost. Establishing the balance between cost and benefit is at the centre of the agenda within the context of what government refers to as its social obligations. Thus the challenge is to find ways of securing greater net benefits for society through public transport enhancement, as well as ensuring that existing public transport is delivered in the most efficient way. Value for the scarce subsidy dollar has become a common statement by the regulatory regime responsible for looking after the social obligation.

What are the themes that we should be documenting which are worthy of review and comment within this setting? As key sentiments they must (at least) include protecting existing market share, growing market share, competing with the car where it makes sense and respecting niche opportunities. Ways in which these sentiments have been 'exploited' in the past (with varying degrees of success and failure) by direct action in the public transport domain include the introduction of new technologies (e.g., light rail, busway systems, smart cards), network integration (e.g., integrated ticketing, coordinated timetables), revised contracts that require minimum service levels and especially minimum spatial coverage and innovative fares (including caps on maximum fares).

Importantly, all such initiatives must be subject to a number of reality checks to ensure some chance of success. Scenario planning can assist this search for achievable outcomes as well as giving a holistic focus. Such scenarios might be described in terms of resources required and support available to deliver outcomes. Lieberman, Schumacher, Hoffman, and Wornum (2001) suggest four broad classes of scenarios linked to financial and planning criteria that highlight the broad settings within which it makes sense to assess new initiatives. The four future scenarios are summarised in a table matrix (Table 20.1).

Table 20.1. Recognising the Financial and Planning Capabilities of Future Scenarios.

	CF	OF	PT-LUC	PTPM
Basic mobility	Low	Low	Low	Low
Mobility plus	Low—moderate	Low–moderate	Moderate	Moderate
Second car disposal	Moderate	Low–moderate	Moderate	High
Public transport first	High	High	High	High

CF, low capital funds for acquisition and construction; OF, low operating funds to provide existing and new public transport services; PT-LUC, low public transport and land use coordination; and PTPM, low public transport priority measures.

With the key sentiments recognised and affordability identified by the four scenarios, there are a number of essential issues to be contemplated by all stakeholders. This contemplation should be done within a framework that ensures that we have some way of identifying the global objectives and delegated responsibilities in delivering desirable outcomes. The strategic tactical operations (STO) paradigm provides a useful framework within which to position these sentiments (and scenarios). Van de Velde (1999) and Hensher and Macario (2002) among others provide details of STO but, in summary, it offers an attractive setting within which to evaluate mechanisms consistent with a holistic (or system-wide) perspective on service delivery and social obligation.

STO is defined by:

- The strategic level, where the focus is on the establishment of broad goals and objectives and guidance on ways of achieving outcomes consistent with such goals ("what do you want to achieve" – Van de Velde, 1999).
- The tactical level, which highlights the supporting mechanisms to achieve the strategic goals (and is where the regulator has a key role).
- The operational level, which focuses on delivering the desired services to the market, consistent with the strategic intent and aided by tactical mechanisms.

Recognising the financial and mobility imperatives and links back to the strategic objectives set out within an STO framework provides the boundaries within which to evaluate opportunities to grow public transport patronage. It also sends clear messages to the tactical and operational levels of responsibilities.

20.3. PRACTICES THAT OFFER PATRONAGE OPPORTUNITIES

There is no shortage of literature offering advice on what matters to travellers in respect of modal choice. However, the focus is, so often, on broad-based generic 'solutions' to patronage growth and retention that often fail to recognise the enormous constraints preventing logical application of such advice. In this section, we attempt to highlight what might be seen as some of the most promising initiatives in delivering patronage growth that are within generally recognisable achievable bounds as perceived to exist within the political, commercial and regulatory settings in Australia.

There is a tendency under existing regulatory regimes to mandate minimum spatial coverage under a minimum service level regime that often has tended to spread a thin market even thinner.[163] As nice and equitable as this contract condition may appear, it has not worked to secure patronage.[164] Growing patronage requires identifying and servicing specific corridors where one can focus on a high-quality service in terms of frequency, reliability, travel time, visibility and security. The promotion of transitway systems accords with this, although one does not necessarily have to commit large sums of money to establishing well-defined and serviced corridors. There are strong signs of a move back towards this perspective in the UK (outside of London), where thinning of services for spatial coverage has been singularly unsuccessful in patronage retention and growth.

The corridor focus is not new but needs to be moved to a higher plane. It is consistent with doing a relatively few things very well and building on their successes (and even learning from the failures). The Brisbane Transit plan is such an example where regional transit's role is to serve as every household's second car (the 'second car disposal' scenario). Other best practice guidelines that emanate from the literature (with a strong strategic and tactical focus and responsibility) include:

- Design the right product for the right role. Examples would include establishing whether one is serving the transit dependant or mode choosers. This highlights the niche approach.
- Differentiate on the basis of service and not mode. For example, Ottawa (Canada) has a mode-neutrality policy for service development which supports the appropriateness of any modal input unimpaired by enshrined modal regulations. A very good example is the use of taxis as buses in very thin markets (with fares charged at bus levels and the difference reimbursed by government).
- Link the centres. Public transport's track record on leading land use is mixed.
- Re-invent the bus (rubber-tyred vehicles). Bus-based systems can mimic the operating characteristics of light rail systems allowing higher-grade bus services to be provided in corridors where rail would be infeasible or inappropriate (Hensher, 1999).
- Design from the results backwards. Begin with a set of system performance goals and design backwards to arrive at a public transport product.

The Curitiba bus system in Brazil is a notable example (Smith & Hensher, 1998, Chapter 17).
- Focus growth strategically. Tie improvements to the bus and rail network to increases in housing and employment densities in corridors and service nodes. This is the focus in Calgary, Canada.

On a more operational level, the examples of key practices and public policies favourable to public transport use can be summarised under two headings: (i) reliability and frequency of service and (ii) comfort, safety and convenience of service. Appealing initiatives under (i) are:

- Wide spacing between bus stops at a route level to increase operating speed as part of a review of the role of express or limited stop services supplemented by all-stops services in accordance with improving accessibility.
- Prepaid tickets and boarding passes to expedite passenger boarding.
- Low-floor buses with wide doorways to speed boarding and alighting.
- Bus priority in mixed traffic such as bus lanes and special signalisation.
- Vehicle locator systems (especially use of global positioning systems and other tracking tools).

Appealing initiatives under (ii) are:

- amenities at bus stops and stations;
- clean vehicles and knowledgeable drivers;
- convenient ticket purchasing places;
- footpaths leading to stations and secure lighted waiting areas;
- uniform and simplified fare structures across all public transport modes;
- discounted public transport passes tailored to individual needs;
- widely published schedules and colour-coded matching buses and lines; and
- taxi services to extend and complete public transport networks (focusing on service and not modes).

Some of these initiatives are more likely to retain than grow patronage. As a package of initiatives they highlight the importance of quality partnerships between operators and infrastructure providers (something totally consistent with the STO framework). Increased spacing between bus stops may initially raise concerns, but if developed under a plan of higher frequency in a corridor with each existing bus stop being served as frequently as before, it offers a much improved service level. This initiative would struggle if spread thin, and highlights the appeal of a corridor focus. Cross-regional services in a number of Australian cities have demonstrated the virtues of the corridor emphasis.[165]

20.4. THREE HIGH AGENDA THEMES TO GROW PATRONAGE

In promoting the suite of initiatives in the previous section, we have identified three themes that can add substantial pro-active context to delivering patronage growth. These are the recognition of changing segments of potential public transport users (moving away from the historical stereotypes), the focus on individualised marketing to secure commitments to modal switching and the opportunities to deliver technology solutions that are the outcome of serving the passenger best rather than a blind commitment to specific technological ‘solutions’.

20.4.1. Rethinking Stereotypical Segments of Potential Public Transport Users

As populations age and remain healthier well into their senior years, the standard socio-economic descriptors that have evolved as stereotypes for public transport use begin to fail. It is commonly asserted that elderly[166] residents are prime candidates for public transport use, described as short on money and long on time and hence captive to public transport. Thus, low fares go with long meandering routes with relatively low frequencies. Increasingly, however, elderly residents fail the stereotypical test. Many are relatively wealthy, have a driving licence and a car, lead active lives and are short on time.[167] Speed and comfort may be more important than low fares.

An alternative segmentation may be best defined by service perceptions and attitudes. Lieberman et al. (2001) proposed a very interesting grouping based on the need for flexibility, speed and personal safety. They proposed six classes of individuals in terms of their travel requirements and expectations (Fig. 20.1).

- Road runner: High need for flexibility and speed and high sensitivity to their personal travel experience.
- Cautious runabout: High need for flexibility and speed but moderate sensitivity to their personal travel experience, distinguished from intrepid trekkers by their lesser concern for personal safety.

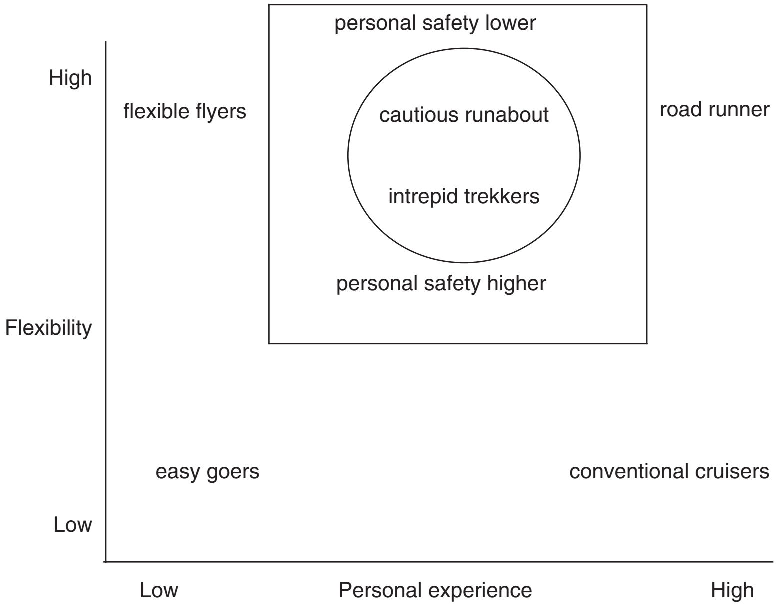


Fig. 20.1. The Diversity of the New 'Stereotype'.

- Intrepid trekkers: High need for flexibility and speed but moderate sensitivity to their personal travel experience, distinguished from cautious runabout by their greater concern for personal safety.
- Flexible flyers: High need for flexibility and speed but low sensitivity to their personal travel experience.
- Conventional cruisers: Low need for flexibility and speed but high sensitivity to their personal travel experience.
- Easy goers: Low need for flexibility and speed and low sensitivity to their personal travel experience.

These segments mapped to socio-economic and demographic descriptors are likely to provide a more useful basis for seeking out potential patronage for public transport. The presumption that this classification can be 'explained' by age and income is likely to be false. In particular, this classification process can materially assist the 'search' for high-eligibility candidates for switching to public transport under individualised marketing programmes to which we now turn.

20.4.2. The Niche Hard Sell – Individualised Marketing

The technique known as ‘individualised marketing’ (Indimark) has been promoted in recent years as a way of seeking out the serious potential switchers from car to public transport. The method has been applied to over 50 public transport projects in 13 different European countries (Brog & Erl, 1996). It was piloted in the City of South Perth (Western Australia) in November 1997 (James, 1998) under a programme called Travel Smart (and similar programme in Adelaide called ‘Living Neighbourhoods’, which also integrates transport with other related goals such as health and amenity).

The sampling approach (Socialdata, 2003) was as follows:

Total sample	498 households
Responded to baseline travel survey	383 households (77%)
Offered the intervention service	383 households
Classified as ‘interested’ (I)	138 households or 36% of (2)
Classified as ‘regular users’ (R)	34 households or 9% of (2)
Classified as ‘not interested’ (N)	188 households or 49% of (2)
Declined to take part in classification	23 households or 6% of (2)
After survey	169 households net from a sample of 200 households in (2)
Control group	153 households net from random sample of 170 not in (2)

Classification took place during telephone interviews to identify ‘regular users’ (R) of alternatives to the car and for interviewees to nominate themselves as ‘interested’ (I) in reducing their car use. The sampled households classified (I) were offered access to a range of maps and brochures on travel options. Following the delivery of the information, 56 of these households requested further assistance and were visited by the public transport operator and provided with a free transit pass for one month. All participants who ordered information were given a reward. Regular users of public transport were also given a reward “in the form of a letter from the public transport operator, a small gift or a home visit by Socialdata” (James, 1998). The follow-up survey included a sample of the target group representative of those classified I, R and N. These individuals showed a 14% reduction in vehicle kilometres travelled by car (associated with 2.9 trips per car per day in contrast to 3.3 trips per day previously, with no change in personal mobility of 3.4 trips per person per day).

This 14% has been widely quoted and has become an indicator of what an entire population might do. Subsequent studies, and further larger scale applications of this approach (Socialdata, 2003) have shown a similar level of reduction in car driver trips. Pilot testing is being carried out to establish the degree to which the South Perth results can be transferred to more challenging areas. Car driver trip reductions of 6–9% (relative) have been achieved in pilots in a regional centre and a market town in the UK (Sustrans, 2002) and a 7% car driver trip reduction achieved in an area of Perth with low levels of walking and public transport use associated with areas of 'garden city' street design without footpaths (Colin Ashton-Graham, personal communication). The outcome of the current round of pilot testing is likely to be prioritised programmes covering parts of metropolitan areas. These are the appropriate market niches for Travel Smart. Further, policy makers are becoming more aware that travel behaviour modification needs to be seen as one of an array of transport strategies that need to be implemented together, to realise significant and sustainable reductions in car use.

20.4.3. Technology at Play

The debate on light rail versus bus-based transitway systems as preferred ways of delivering high-level public transport service continues unabated, with evidence being offered in support of both technologies. Hensher (1999) reviewed the evidence under the banner of choice or blind commitment. Positions change as 'evidence' accumulates. For example, swayed by the research of Hass-Klau and Crampton (2002),[168] the (then) UK Deputy Prime Minister John Prescott stated (in July 2000) that "I have changed my mind. I wasn't convinced about light rail systems, which can be expensive, but I think in some cities they are the way forward". Prescott further stated that "… people who won't use buses will go by light rail". Surely a false premise! According to Hass-Klau and Crampton, UK light rail systems meet the key criteria to attract motorists out of their cars. These criteria are reliable, frequent, efficient, safe and clean transport with affordable fares. Why should this apply to light rail and not busway systems? The latter are typically one-third of the cost of light rail for the equivalent passenger capacity or the same cost for three-times the passenger capacity.

The recently opened 16 km state-of-the-art South East Busway in Brisbane is an example of a busway system that has exceeded expectations in ridership. In the first six months of operation, the number of passengers has grown by 40% or by more than 450,000 new passenger trips, giving a daily average of 58,000. It is reported (in *The Urban Transport Monitor*, 8 February 2002) that 375,000 private vehicle trips have been converted to public transport. Pittsburgh's (8 km) third busway, which opened in September 2000, has secured average weekday patronage growth of 23% over the last 17 months. Currently, Pittsburgh averages 48,000 daily passenger trips on the full busway system of 43.8 km OK.

Hass-Klau and Crampton (2002) suggest that "[The] … high cost and inflexibility of light rail – often considered to be drawbacks – actually turn out to be its main advantages". This is a very strange defence indeed. They argue that inflexibility is actually 'code' for security – the population is confident that a change of political power or financial situation will not result in the new system being taken away from them, and can therefore plan their lives knowing that the system will be there in the future. This seems incredible given the copious evidence to support the demise of light rail (or tram) systems historically. Finally, Hass-Klau and Crampton state that "… the infrastructure costs are closer together than has often been assumed". They quote busways at £526,000 per kilometre and light rail (and guided busways) at £561,000–£702,000 per kilometre. From this evidence one would hardly conclude that light rail is more favourable.[169] The best case is 6.6% more expensive and it is more likely to be 23.5% on capital costs. A salient lesson from the ongoing debate on technology preference (or is it bias/ideology?) is that one should be distance thinking from an obsession with technology and move to studying the needs as a starting point of inquiry. Do not ask if a particular technology is feasible, but ask who the stakeholders are and proceed to investigate how they may best be served. Let technology assist and not lead.

20.5. CONCLUDING COMMENTS

Central to a well-articulated evaluation of new initiatives within the STO framework is a needs assessment driven by a number of well-articulated questions.

1. What is the set of criteria used to evaluate and justify (or not) a specific initiative?
2. What are the commercial and social consequences of the initiative?
3. How broadly based should the evaluation of the initiative be? This includes geographical coverage, forecasting period, market segments and the set of alternatives to evaluate.

4. Is there a market for the initiative?
5. What is the risk profile of the set of alternatives?
6. What specific outcomes does each stakeholder seek from the initiative?
7. What role might government play in the evaluation process?
8. How might one develop and execute a marketing strategy to reinforce the forecasted market potentials between the point at which forecasts are established and the commencement of the initiative?

The two most critical issues from this set of questions are the coverage of the needs study and the risk profile of the outputs. The other issues are important but are incorporated as interpretations of the information delivered from a market study. For example, the government's commitment to social obligations can be provided via output measures such as improved accessibility, reduced traffic congestion and improved air quality, which are associated with a forecast of changing traffic on the network in the presence of a specific infrastructure scenario. A range of scenarios can assist in both establishing the degree of risk attached to a specific initiative (e.g., the forecasts of patronage) and pinpointing the preferred scenario, given the set of criteria for measuring performance.

What is, however, very clear is that public transport is here to stay, but with real patronage growth opportunities as a niche provider. As a niche provider it must be much more responsive to the needs of the specific markets it might serve. Governments must recognise that these niches exist and support the operators in identifying and developing in these markets through appropriate incentive schemes by sharing the risks and the rewards. If these incentives are structured within a contract regime, such contracts should get away from the requirement to thinly serve thin markets and have greater faith in real markets where opportunities for patronage growth exist. Existing contract regimes appear in the main to stifle this opportunity by directing resources to services where the carriage of 'fresh air' is not uncommon (and in some cases where the only bus passenger is the driver). Performance-based contracts (as outlined in Hensher & Stanley, 2003) can be very effective within a setting where patronage growth comes about by initiatives including niche treatments.

Critical to the ongoing search for opportunities to grow patronage is a much stronger behavioural focus in which behavioural change must be the key driver. Understanding where this might come from and what incentives are required to secure such change must be at the top of a reform agenda.

This page intentionally left blank

CHAPTER 21

URBAN PUBLIC TRANSPORT AGENDAS AND CHALLENGES

21.1. INTRODUCTION

Public passenger transport systems (notably bus and rail) are unquestionably an important part of the transport task. A continuing challenge, however, is to protect existing market share and grow new market share in the presence of the automobile. Public transport does not necessarily have to find ways of narrowing the gap between what public transport and the car can deliver from a user's perspective, but it does have an obligation to compete where it makes good sense to do so. This is an age-old challenge that has resulted in the positioning of public transport as a niche market provider. There is nothing undesirable about niche provision in markets such as central city and regional centre commuting, the unemployed, students, special event attendance and tourists. Excluding non-local tourists, bus and train represents less than 10% of all urban passenger activity in Australia.

Why is it so difficult to gain market share? It has always been understood that the appeal of the car is characterised by its immediate availability, its predictability, flexibility and seamless delivery door-to-door. In contrast bus and train are characterised by relative inflexibility, unpredictability (i.e., reliability) and disconnectedness. Note the absence of a financial consideration.

This chapter draws out the distinction between what has real prospects of attracting ridership (or at least servicing existing patronage more cost efficiently) and what are debates that affect the operational status of public transport but do not appear to impact in any noticeable way on growing the market. This distinction is useful, highlighting the gains that can be made in terms of operational efficiency without any significant expectation of patronage growth (what occurs is a bonus). Far too much faith is placed in a diversified set of operational improvements as ways to grow the market that often deliver higher costs and few or no net benefits. For example, the opportunities afforded by electronic technologies (e.g., ticketing, information signage) may have enabled operators to deliver a given level of service more efficiently (and this is commendable) but the impact on patronage gain appears to be negligible. The same might be suggested for low-floor buses. The qualification, as always, is that we do not have the counterfactuals so inferences are to some extent judgemental, but often close to the 'truth'.

The chapter is structured as follows. We begin by establishing the role of public transport in the passenger transport task in the Sydney metropolitan area where buses and trains have more visibility than any other Australian city (with the possible exception of Melbourne). We then comment on some of the continuing challenges facing public transport in the presence of popular automobility. The following section accepts the market limits of public transport (except at the margin) and revisits the ongoing debate on the role of light rail and busway systems as a 'panacea' for future growth. Given the future prospects for buses, the next section assesses the strongly politically focused debate on converting the bus fleet to alternative fuels, especially compressed natural gas (CNG), a high agenda theme of the Federal government. As ultra low sulfur diesel and advanced Euro 4 engines become available (together with particulate traps),[170] are we acting in misinformed haste in the switch to 'cleaner' CNG? The final section preceding a conclusion returns us to the ultimate agenda of delivering service effectively.

21.2. CHANGING THE BALANCE IN FAVOUR OF PUBLIC TRANSPORT

Tables 21.1 and 21.2 for the Sydney metropolitan area highlight the changes over the last 20 years in modal activity, travel time outlaid and distance travelled for all person travel by motorised and non-motorised passenger modes. Most notable is the decline in the market shares for bus and train on all three dimensions despite the absolute increase in train modal activity, travel time and distance travelled. The car captures over 60% of passenger trip activity (when walking is included, the latter capturing 28% of modal share), six times that of public transport. When expressed in passenger kilometres, however, the car represents 78.7% of all travel activity with public transport 14.7%, a ratio of 5.35:1. The longer average trip length for train travellers (18.5 km) is a major influence offsetting the shorter bus trips (6.72 km) in comparison with 10.53 km for car driver and 9.2 for car passenger. Trains produce more than twice the number of passenger kilometres than buses although absolute passenger trips are higher for bus, 22% higher in 1997/1998, 32.5% higher in 1991 and 56.9% higher in 1981.

Table 21.1. Profile of the Transport Task 1981–1997/1998 for Sydney Metropolitan Area: Average Weekday.

	1997–1998	1991	1981
Mode	Unlinked trips per average weekday		
Vehicle driver	7,619,762	6,366,108	5,718,794
Vehicle passenger	3,573,322	2,850,305	2,188,825
Train	*784,281*	*691,325*	*706,922*
Bus	*960,897*	*916,860*	*1,108,430*
Ferry	*37,030*	*32,725*	*34,646*
Taxi	99,490	102,523	94,673
Walking	5,163,525	4,774,261	4,774,437
Other	133,742	137,715	173,752
Total	18,372,049	15,871,823	14,800,479
Mode	Unlinked time (min) per average weekday		
Vehicle driver	142,582,457	112,746,845	95,138,147
Vehicle passenger	59,439,904	44,926,403	34,158,674
Train	*22,745,893*	*20,148,483*	*19,824,131*
Bus	*19,824,220*	*18,387,440*	*20,579,671*
Ferry	*956,461*	*704,246*	*797,876*
Taxi	1,963,160	1,811,141	1,543,550
Walking	44,114,861	44,419,513	40,739,660
Other	4,496,711	2,335,141	2,492,875
Total	296,123,667	245,479,211	215,274,584
Mode	Unlinked distance (km) per average weekday		
Vehicle driver	80,258,542	64,038,066	47,785,325
Vehicle passenger	32,716,221	25,982,617	16,524,502
Train	*14,505,298*	*13,491,745*	*11,659,431*
Bus	*6,457,063*	*5,962,601*	*6,225,603*
Ferry	*406,708*	*325,668*	*356,052*
Taxi	649,775	615,495	493,564
Walking	7,888,044	9,015,489	7,890,821
Other	668,976	515,173	543,402
Total	143,550,627	119,946,855	91,478,700

	1997–1998	1991	1981
Mode	Average Speed (kph)		
Vehicle driver	33.77	34.08	30.14
Vehicle passenger	33.02	34.70	29.03
Train	*38.26*	*40.18*	*35.29*
Bus	*19.54*	*19.46*	*18.15*
Ferry	*25.51*	*27.75*	*26.77*
Taxi	19.86	20.39	19.19
Walking	10.73	12.18	11.62
Other	8.93	13.24	13.08
Total	29.09	29.32	25.50
Mode	Average distance per trip (km)		
Vehicle driver	10.53	10.06	8.36
Vehicle passenger	9.16	9.12	7.55
Train	*18.50*	*19.52*	*16.49*
Bus	*6.72*	*6.50*	*5.62*
Ferry	*10.98*	*9.95*	*10.28*
Taxi	6.53	6.00	5.21
Walking	1.53	1.89	1.65
Other	5.00	3.74	3.13
Total	7.81	7.56	6.18
Trip purpose	Mean car occupancy		
HB work	1.12	1.12	1.11
HB shop	1.50	1.51	1.28
HB education	1.13	1.16	1.16
HB social recreation	1.64	1.62	1.53
HB personal business	1.38	1.40	1.25
HB other	1.97	1.94	1.33
Non home based	1.55	1.51	1.11
Total	1.53	1.51	1.26

Note: Distance is passenger kilometres.
Source: Transport Data Centre Household Travel Surveys (1981, 1991, 1997/1998).

Table 21.2. Changes in Public Transport Shares in Sydney 1981–1997/1998.

	Share 1997–1998	Share 1991	Share 1981
Mode			
Vehicle driver	0.415	0.401	0.386
Vehicle passenger	0.194	0.180	0.148
Train	0.043	0.044	0.048
Bus	0.052	0.058	0.075
Ferry	0.002	0.002	0.002
Taxi	0.005	0.006	0.006
Walking	0.281	0.301	0.323
Other	0.007	0.009	0.012
Total	1.000	1.000	1.000
Public transport (train, bus, ferry)	*0.097*	*0.103*	*0.125*
Distance			
Vehicle driver	0.559	0.534	0.522
Vehicle passenger	0.228	0.217	0.181
Train	0.101	0.112	0.127
Bus	0.045	0.050	0.068
Ferry	0.003	0.003	0.004
Taxi	0.005	0.005	0.005
Walking	0.055	0.075	0.086
Other	0.005	0.004	0.006
Total	1.000	1.000	1.000
Public transport (train, bus, ferry)	*0.149*	*0.165*	0.199
Travel time			
Vehicle driver	0.481	0.459	0.442
Vehicle passenger	0.201	0.183	0.159
Train	0.077	0.082	0.092
Bus	0.067	0.075	0.096
Ferry	0.003	0.003	0.004
Taxi	0.007	0.007	0.007
Walking	0.149	0.181	0.189
Other	0.015	0.010	0.012
Total	1.000	1.000	1.000
Public transport (train, bus, ferry)	*0.147*	*0.160*	*0.191*

Source: Transport Data Centre Household Travel Surveys (1981, 1991, 1997/1998).

Why is this happening to public transport? Fig. 21.1 provides a synthesis of some key elements of the changing face of Australian society that are impacting on the future of urban public transport. These evolutionary changes also apply to countries with historically stronger urban public

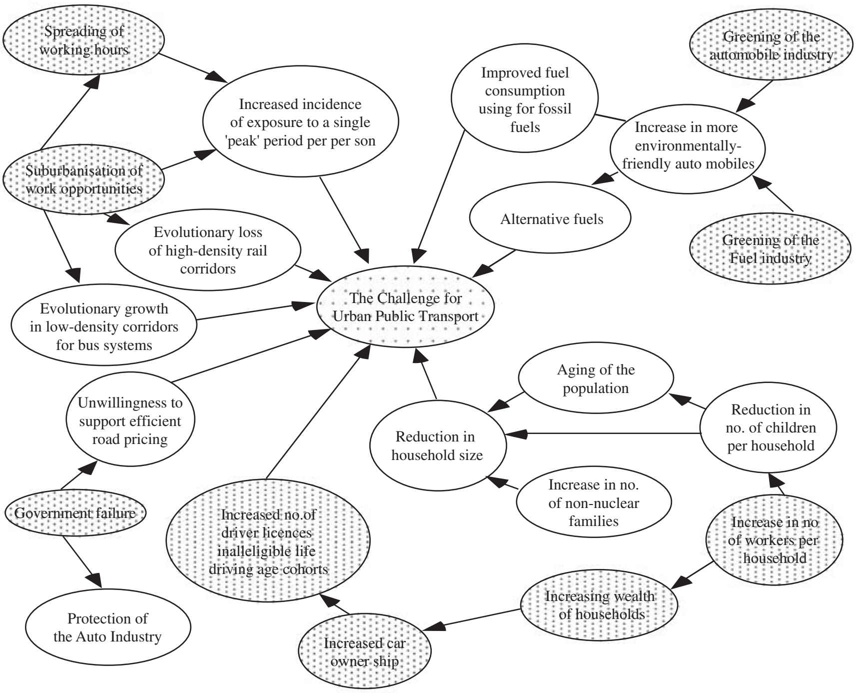


Fig. 21.1. The Challenges for Urban Public Transport.

transport such as many Western European countries and Canada, as they are two countries such as Australia and the USA which have run down their public transport in the last 50 years and are now trying to reverse this trend. The key influences on change in the urban passenger transport sector include the changing composition of the labour force and work schedules, the suburbanisation of work opportunities and the accompanying loss of high-density mobility corridors (but an increasing number of low-density corridors more suitable for bus systems than rail), the changing incidence of the population in each life-cycle stage producing greater wealth, the commitment or lack thereof from government to pricing and planning/regulatory reforms, the growing awareness and acceptance of user or beneficiary charges and the greening of the automobile.

Many supporters of public transport often turn to Europe, for examples, of success. However, the encyclopedic account of tradition and transition in European travel patterns in Salomon et al. (1993) portrayed as a 'billion trips a day' paints a worrying picture. They show an increasing rate of growth of car ownership (nearly three times that of the USA – Lave, 1992), declining household size, suburbanising residential location and the decline of the central city as the dominating focus of activity.[171] The annual growth rate in personal mobility from 1970 through to the early 1990s associated with private modes in Europe varies from a low of 1.7% in Sweden to a high of 6.8% in Portugal (with most countries around 3%). The use of urban public transport grew at a negative rate in the UK (−0.9%) and Belgium (−0.4%) and up to 3.6% in Denmark (with most countries between 1 and 2%) (Bovy, Orfeuil, & Zumkeller, 1993). The share of mobility contributed by the private car increased from 79 to 83% during this period. Italy has one of the highest modal splits for urban public transport (26%), with a low of 4.8% in the Netherlands, and a typical percentage share of 11–19% throughout Western Europe.

The accumulating evidence tells us repeatedly that individuals most likely to use urban public transport in settings with a wealth base such as Australia are

- school children;
- low household income households (but not necessarily low personal incomes for multi-worker households);
- a declining proportion of the elderly (those without drivers licences or who are physically unable to drive and who have limited access to support networks which provide private or community car-based transport);
- those who have no automobile available in the household;
- people who live in a central city and work in or adjacent to the central business district, and who live in a densely settled area;
- urban tourists (mainly central city services); and
- special events (such as the Olympics, the Easter Show and the Grand Prix).

In the context of the commuting trip, workers satisfying these criteria typically exhibit a public transport use in excess of 70% in many cities. Such workers, however, are a declining percentage of the workforce. For example, in the USA they are less than 4% of all commuters today. In Western Europe, in large cities such as Paris we find that the share of commuters living in/near and working in the central city is 17% and is declining, with massive growth of commuting from persons living and working in the suburbs − 48% of commuters in 1982 (Jansen, 1993). The question remains – what can we do to reverse the trend away from public transport use (assuming this is desirable).

21.3. THE ONGOING DEBATE ON TECHNOLOGICAL FORMS OF PUBLIC TRANSPORT: BUS SYSTEMS AND LIGHT RAIL REVISITED YET AGAIN!

> 'I have changed my mind. I wasn't convinced about light rail systems, which can be expensive, but I think in some cities they are the way forward' John Prescott, UK Deputy Prime Minister

> Local Transport Today (22 June 2000) commenting on the report on Bus or Light Rail: Making the Right Choice (Environmental and Transport Planning 2000) which states that'… the high cost and inflexibility of light rail-often considered to be drawbacks – actually turn out to be its main advantages. The report states that '… Inflexibility becomes redefined as security – the population is confident that a change of political power or financial situation will not result in the new system being taken away from them, and can therefore plan their lives knowing that the system will be there in the future' (Environmental and Transport Planning, 2000).

I wonder what happened to the tram system in Sydney that disappeared in the 1960s? Are the quotes above indicating that the changing financial situation guarantees further subsidy? So, the sorry saga continues and creates more emotion than sensible review and assessment.[172] Apparently in the UK, light rail systems meet the key criteria to attract motorists out of their cars-reliable, frequent, efficient, safe and clean with affordable fares. Well, why not busway systems which are less costly to provide?[173] Why suddenly the turnaround and implication that busway systems cannot covert this great prize? The UK turnaround appears to be more a case of a desire to be seen to be taking firm action on an issue that will generate positive headlines (until it is known what cost overruns are likely to occur and the escalating subsidy) (Mackett & Edwards, 1998). The old adage that "buses are boring and trains are sexy" is alive and well.

Mr Prescott has announced that people who would not use buses *will* go by light rail. This is based on the false premise that there is something inherently more attractive about light rail. The evidence is rather that people overwhelmingly choose on the basis of time and price. Replace the bus system with a more frequent, faster light rail service, and of course more people will use it! But the report that 20% of Manchester light rail users had previously driven is hardly an achievement, given the money spent. All the evidence from cities which have invested in enhanced bus systems, with similar prioritised rights-of-way and travel times, is that they are just as effective in attracting riders, and often more so, but cost much less (Hensher, 1999; Richmond, 1998).

Not only does light rail, which is often slower than revitalised bus systems, have the potential to interfere with existing road traffic, but the 'park and ride' lots featured in the USA, and which the Government wishes to emulate in the UK, encourage people to drive to stations.[174] Many individuals who previously took the bus all the way to work in light rail cities such as Denver, St Louis and Buffalo, now take the car part of the way, adding to pollution and congestion (Richmond, 2000). Because light rail provides direct service to fewer places than buses, moreover, those who lack the cars to get to the light rail stops often lose out because they must change more often, in many cases with resultant longer journey times.

Buses, especially bus-based transitway systems are arguably better value for money and if designed properly can have the essential characteristicity of permanence and visibility claimed to be important to attract property development along the route that is compatible with medium to high-density corridor mobility. To achieve this, however, the bus industry needs a 'wake-up' call. The opportunities are extensive but the industry is far too traditional (often complacent), often lacking lateral thinking and not pro-active enough (with very few exceptions). Despite the appeal of bus-based transitways, there is still a lot that can be achieved by simple bus solutions such as adding more buses, adjusting fare schedules, improving information systems, integrating ticketing, all of which is lost in the debate over whether special rights-of-way for buses as against light rail are better.

The ongoing debate on busway systems versus light rail may well have sent us off in the wrong direction. Technology fixation focuses the mind in ways that can be counterproductive. Hensher (1999) reviewed this debate under the banner of choice or blind commitment and concluded that we should distance our thinking from an obsession with technology and move to study needs as a starting point of inquiry. Do not ask if light rail is feasible, but ask who the stakeholders are and proceed to investigate how they may best be served. Hutchinson (2000) in response supports Hensher's specific conclusions and states that

> Hensher's paper … is certainly an excellent starting point for those studying transport decision-making. It has something about the principles, some case studies, something about the wider planning issues, and something about the obstacles to rationality. I hope that the paper will also be an inspiration, and that it may signal that better decisions and better process are coming to the fore again (p. 68).

There are at least three major issues that have to be constantly addressed in the current climate: firstly, how to counter arguments about the very expensive 'image benefits' bestowed by a brand new light rail system that a bus-based system cannot provide; secondly, how to amend funding mechanisms so that the maximum benefit is obtained from the investment of public money in urban transport; and thirdly, how to amend the analytical process so that it does not over estimate the benefits of a new public transport system.

The first two issues are related. The usual procedure in many countries is for local planners and politicians to promote and design a scheme, and then to secure funding from government (and/or private sources). It remains easier to make the case for a 'high-tech' discrete rail-based system rather than upgrading an existing bus system.[175] What we should be more serious about is a needs assessment driven by a number of well-articulated questions

- What are the set of criteria used to evaluate and justify (or not) a specific proposal?
- What are the commercial and social consequences of the proposal?
- How broadly based should the evaluation of the proposal be? This includes geographical coverage, forecasting period, market segments and the set of alternatives to evaluate.
- Is there a market for the proposal?
- What is the risk profile of the set of alternatives?
- What specific outcomes does each stakeholder seek from the proposal?
- What role might government play in the evaluation process?
- How might one develop and execute a marketing strategy to reinforce the forecasted market potentials between the point at which forecasts are established and the commencement of the project?

The two most critical issues from this set of questions are the coverage of the needs study and the risk profile of the outputs. The other issues, while important, are incorporated as interpretations of the information delivered from the market study. For example, the government's commitment to social obligations can be provided via output measures such as improved accessibility, reduced traffic congestion and improved air quality, which are associated with a forecast of changing traffic on the network in the presence of a specific infrastructure scenario. A range of scenarios can assist in establishing the degree of risk attached to a specific traffic forecast as well as pinpointing the preferred infrastructure scenario, given the set of criteria for measuring performance. Let us not get off on a technology binge yet again!

21.4. ENVIRONMENTAL MATTERS AND BUSES

> Over 93 per cent of fuel consumed by buses is diesel/distillate, with the balance primarily petrol and less than one per cent LPG/LNG. A large number of bus operators (about 60 per cent in NSW) have only one or two vehicles, and eighty per cent have less than 10 vehicles. About 73 per cent of the total number of buses will be replaced when they reach between the age of 16 years and 25 years. The greatest number of buses will be replaced when they are 20 years old. The expected cost (in 1994 prices) of replacement ranges from $15,000 to $560,000 per bus with 50 per cent of the buses expected to cost over $195,000. On average, the automatic vehicles across all ages are less fuel-efficient and produce more CO_2 emissions than the manual vehicles. (King & Hensher, 1999)

This scenario is fact, describing the current private bus fleet in urban NSW. The Federal government has set in place a programme to have buses switch from diesel to CNG over a 15-year period. But does it really make any environmental sense? The Perth Expert Reference Group (1998) (ERG) report (see also Stanley, 2000) presented estimates of emission rates for various engine/fuel type combinations, based on research and submissions to the Group which were supplemented by Bus Industry Council (BIC) subcommittee estimates of emission rates for some vehicles/fuels not covered by the Group (BIC, 1999, see also Burnbank Consulting and Tasman Asia Pacific, 1999). The BIC sub-committee estimated what level of emission reduction in the *existing* diesel fleet might be achieved by switching to low sulfur fuel, an outcome that does not rely on changeover of vehicles to achieve the reductions. Table 21.3 summarises estimates of how emission rates compare between diesel and gas under various combinations of fuel and emission control technologies.

Table 21.3. Emission Rates from Various Engine/Fuel Combinations (g/km).

Treatment	HC	CO	NO_x	CO_2	PM_{10}
E2D 500 ppm S	0.64	1.35	15	1,386	0.23
E2D 50 ppm S	0.63	1.38	14.2	1,351	0.157
E2D 50 ppm, CAT	0.328	0.274	13.41	1,288	0.083
E2D 50 ppm, CRT	0.136	0.203	11.93	1,282	0.022
CNG with Oxycat	3.01	0.66	9.92	1,344	0.05
LPG with three-way CAT	0.027	0.0132	5.4	1,309	0.017

Note: E2 is the Euro 2 (European) emission standard; D, diesel; S, sulfur; CAT, catalyst; CRT, continuously regenerating particulate trap; Oxycat, oxidation catalyst.
Sources: ERG (1998, Table 11, p. 46).

A Euro 2 diesel operating on ultra low sulfur diesel (50 ppm) with a catalyst or continuously regenerating particulate trap (CRT) produces similar particulate and NO_x emissions to a CNG vehicle with Oxycat. The Euro 2 plus ultra low sulfur diesel fuel with CRT is *lower* for particulate emissions than the CNG with Oxycat. Particulate emissions are generally accepted as the emissions of most current concern.[176] Table 21.3 indicates that there is little to choose between diesel and gas on grounds of greenhouse gas emissions (see the CO_2 emissions). Estimates for Euro 3 diesel vehicles from Chassis supplier MAN, supported by Scania, suggest that these emissions are likely to be below the nominated Euro 3 emission limits (Table 21.4).

BIC also emphasises that low sulfur diesel has the environmental benefit of lowering emissions from all diesel vehicles which use the fuel, not just new vehicles. Existing fleets are mainly Euro 0 and 1 compliant. MAN has tested a Euro 1 engine operating on distillate with a sulfur content of 1600 ppm, or 0.16%, which showed a reduction in particle emissions of about 22–28%, compared to the same engine using fuel with a sulfur content of 400 ppm or 0.04%. MAN also estimates that a Euro 0 diesel engine can probably achieve up to 50% reduction in particulate emissions by using low sulfur fuel, i.e., Euro 2 standard fuel 500 ppm or 0.05%.[177]

The environmental gains in converting to CNG are dubious. When the costs of compliance are worked out, one wonders about the logic. To investigate this, a base case and three alternatives have been considered by the BIC sub-committee of which the author was a member. Table 21.5 sets out the analysis results for these alternatives, compared to the base case.

A *base analysis* case includes a capital cost penalty of $45,000 for a new CNG bus; engine rebuild costs for the CNG vehicle at $20,000 after 700,000 km and at the same amount for diesel after 1 million kilometres; $13,333 per vehicle infrastructure (gas supply) cost for CNG; residual value $15,000 less for the CNG vehicle than for the diesel at 15 years; cylinder testing at $2,500, in most States, every 3 years for CNG; fuel cost

Table 21.4. Euro 3 Standards.

	Permissible Euro3 Standard (g/kWh)	Expected Reduction in Standard (g/kWh)
Hydrocarbons (HC)	0.66	0.6
Carbon dioxide (CO_2)	2.0	0.5
Nitrogen oxides (NO_x)	5.0	4.7
Particulates (PM)	0.10	0.1

Source: BIC (1999).

Table 21.5. Alternative Evaluation Results: 1999 Present Values, 5% Real Discount Rate.

Item	Base Case ($000)	Converted CNG Engine ($000)	Diesel Price Reduced 23 cents/L ($000)	No Passenger Loading Penalty on CNG ($000)
CNG capital cost disadvantage	95.78	108.16	95.78	90.68
Less CNG operating cost advantage	32.38	13.78	−17.29	76.93
NPV of CNG disadvantage (cf. diesel)	63.40	94.38	113.07	13.74

N.P.V. – Newly Purchased Vehicle. *Source:* BIC (1999).

advantages for CNG; no difference in maintenance costs between diesel and CNG; and a 10% passenger loading penalty for CNG, which affects most of the above costs at the fleet level and is incorporated into the present analysis by applying a penalty to the cost items for the sample individual vehicle.

CNG is expected to be significantly more expensive in capital cost terms but to be less expensive in terms of operating costs. This operating cost advantage is due to the favourable tax treatment of CNG. Overall, the CNG vehicle is projected to have lifetime costs (in present value terms) about $63,400 higher than diesel in this base case analysis.

Three alternative cases were analysed. The *first alternative* was conversion of a diesel bus to CNG. This alternative used net conversion costs of $55,000 for the CNG vehicle, as explained above, cylinder testing costs of $3,000 every 3 years and maintenance costs of 25 cents/km for CNG (compared to 22 cents/km for the new CNG vehicle).[178] A 10% passenger loading penalty has again been assumed for CNG.

The *second alternative* assumed that buses have access to the lower diesel prices that will be available to vehicles over 20 tonnes GVM under the Coalition/Democrats tax package. Diesel prices are effectively lowered by 23 cents/L.[179] This alternative retains the 10% passenger-loading penalty on CNG. Based on its analysis of the European Commission's research, the ERG concluded that the current price differential between diesel and CNG (i.e., 43 cents/L) was appropriate on environmental grounds for older diesel vehicles, but was too large for new vehicles with modern emission controls and operating on low sulfur diesel. For a Euro 2 vehicle using low sulfur diesel fuel (500 ppm) and a catalyst, the ERG's analysis concluded that the relative price advantage of gas should be only about 12.5 cents/L. The assumption of a 23 cents/L reduction in the price of diesel is, therefore, not as great as the reduction that would be economically justified by these results. This alternative can thus be taken as a result which remains relatively favourable to gas, in terms of its environmental advantage over diesel, but it still represents a significant improvement for diesel over the current 43 cents/L price differential.

The *third alternative* assumed that CNG does not have a 10% passenger loading penalty. This alternative assumed purchase of a new gas bus, rather than conversion, and retains the base case price advantage for gas over diesel (i.e., it does not narrow this differential by 23 cents/L).

Table 21.3 indicates that the conversion of the gas bus is an inferior alternative to purchase a new CNG vehicle by about $30,000 in present value terms (i.e., comparing the $63,400 base case figure and the $94,380 figure in the next column). About half this cost differential of $30,000 is attributable to increased capital costs for the converted vehicle and half to a poorer operating result.

Comparing the result in the first and last result columns of Table 21.3 suggests that a 10% passenger loading penalty adds about $50,000 to the life cycle cost disadvantage of CNG (i.e., $63,400 minus $13,740 from the last column). This is a significant impost on gas on a whole-of-life basis, although increasing axle mass limits to the current European limits would remove the passenger disadvantage but not the operating costs as a result of the higher weight. A 23 cents/L reduction in the price of diesel also adds about $50,000 to the cost disadvantage of CNG. The net cost disadvantage to gas increases to $113,070 for this alternative, about $50,000 greater than the base case disadvantage.

At diesel costs of about 70 cents/L for low sulfur diesel and current axle mass limits, the most realistic alternative is number 3. With the cost of a new CNG bus much less than the cost of a converted vehicle, the added cost for CNG over diesel would be about $63,400 in this situation. If the Commonwealth were to fund half the higher purchase cost of the CNG vehicle, some $22,500, this would still leave CNG about $41,000 more costly than diesel on a whole-of-life basis. Over a 3-year period, the Coalition/Democrat package provides $55 million for conversion of diesel (buses and trucks) to CNG/LPG. At $22,500 per (new) CNG vehicle funding assistance, 2,444 vehicles would be converted over 3 years if all the conversion money was spent this way on buses. BIC concludes, however, that few private operators would change to CNG on these cost numbers, even with $22,500 assistance. The projected cost disadvantage of about $63,000 is too high.

Perhaps the most realistic alternative for comparison of diesel and gas is between diesel with a 23 cents/L price reduction, based on relative environmental performance, and gas with the advantages of an increase in allowable axle mass (which effectively removes the loading penalty). In this situation, gas would have a whole-of-life disadvantage of $63,410 on the results of this analysis. The 50% capital grant would remain insufficient to influence many operators to choose CNG in this situation.[180]

21.5. SERVICE QUALITY AND YOUR CUSTOMERS: THE ULTIMATE PURPOSE

The most important issue that all public transport operators (and their regulators) should focus on is the delivery of service quality. But what is an appropriate level? Clearly, the answer must come from actual and potential passengers. In 1999, the Institute of Transport Studies investigated possible ways that the bus industry might capture customers' satisfaction with service levels provided. The Bus and Coach Association (NSW) supported the initiative by encouraging its members to participate as part of a pilot study. In promoting the need for better information on how passengers feel about the quality of services provided, we emphasised that not only might the study provide important insights into how service quality can be built into any future performance assessment regime that Government is contemplating, but that such information is very important to gaining a better appreciation of how effective are service levels from a passengers' point of view and what aspects of service are the ones which are working best and which need some more effort to improve.

An on-board customer survey focused on a current trip and sought information on passenger perceptions of service levels on a number of important attributes. In addition, we utilised the latest ideas in survey design and asked passengers to consider a number of alternative packages of service levels based on 13 attributes (Table 21.6) and to choose which one they most preferred (Table 21.7) relative to the levels of service associated with a current trip. Analysis of this mixture of stated and revealed preference data using discrete choice models identified the contribution of each service attribute to the calculation of an overall index of service quality.

This index, known as the Service Quality Index (SQI), provides a means of establishing overall service effectiveness (from a passenger's viewpoint).

Table 21.6. The Set of Attributes and Attribute Levels in the SP Experiment.

Attribute	Interpretation of Levels	Attribute	Interpretation of Levels
Reliability	– On time – 5 min late – 10 min late	Info at the bus stop	– Timetable and map – Timetable but no map – No timetable and no map
Frequency	– Every 15 min – Every 30 min – Every 60 min	Travel time	– 25% quicker than the current travel time – Same as now – 25% longer than the current travel time
Walking distance to the bus stop	– Same as now – 5 min more – 10 min more	Bus stop facilities	– Bus shelter with seats – Seats only – No shelter or seats at all
Waiting safety	– Very safe – Reasonably safe – Reasonably unsafe	Fare	– 25% more than the current one-way fare – Same as now – 25% less than the current one-way fare
Access to the bus	– Wide entry with no steps – Wide entry with two steps – Narrow entry with four steps	Driver attitude	– Very friendly – Friendly enough – Very unfriendly
Air conditioning	– Available with no surcharge – Available with a surcharge of 20% on existing one-way fare	Safety on board	– The ride is very smooth with no sudden braking – The ride is generally smooth with rare sudden braking – The ride is jerky; sudden braking occurs often
Cleanliness of seats	– Not available – Very clean – Clean enough – Not clean enough		

Importantly the approach can be used to undertake comparisons between operators, between depots of the one operator, comparing overall SQI as well as identifying the contribution of each service attribute to overall SQI. The ability to identify the major positive and negative contributions to SQI is critical to the success of the index since operators must know where they should focus their efforts in the immediate future to improve their performance. The index also reveals which attributes of service, under their control, they can improve that produces the greatest gains in customer

Table 21.7. A Typical Stated Preference Exercise.

Service Feature	Bus Package of the Bus Company A	Bus Package of the Bus Company B	Bus Package of the Current Bus
Reliability	10 min late	On time	7 min late
One-way fare	Same as now	Same as now	2 dollars
Walking distance to the bus stop	5 min more than now	5 min more than now	5 min
Personal safety at the bus stop	Reasonably unsafe	Reasonably safe	Very safe
Travel time	25% longer than the current travel time	25% quicker than the current travel time	30 min
Bus stop facilities	No shelter or seats at all	Seats only	Seats only
Air conditioning	Not available	Available with no surcharge	Not available
Information at the bus stop	Timetable but no map	Timetable but no map	Timetable and a map
Frequency	Every 15 min	Every 30 min	Every 60 min
Safety on board	The ride is jerky; sudden braking occurs often	The ride is jerky; sudden braking occurs often	The ride is jerky; sudden braking occurs often
Cleanliness of seats	Clean enough	Clean enough	Very clean
Ease of access to the bus	Wide entry with no steps inside the bus	Wide entry with two steps inside the bus	Wide entry with two steps inside the bus
Driver behaviour	Friendly enough	Very friendly	Very friendly

If Bus A and Bus B were available today, which bus service would you choose?
☐ Bus A ☐ Bus B ☐ The bus you are travelling on.

satisfaction. It also reveals the importance of service attributes not under the operator's control (e.g., quality of bus stop furniture) and highlights the role of other parties in service provision. This latter information is very powerful for an operator since it can be used to highlight the role of other providers in improving the quality of service delivery rather than pointing all responsibility to the operator.

Some examples of the results from the 1999 study are shown in Figs. 21.2, 21.3 and 21.4, respectively, for the overall SQI and its components (Table 21.8). Further details are provided in Prioni and Hensher (2000) and Chapters 13 and 14. The method is also applicable to other forms of public transport.

21.6. CONCLUDING THOUGHTS: TRANSPORT-FRIEND OR FOE?

While public transport is here to stay, what is uncertain is its future role and its ability to be more responsive to the needs of the markets of the future in

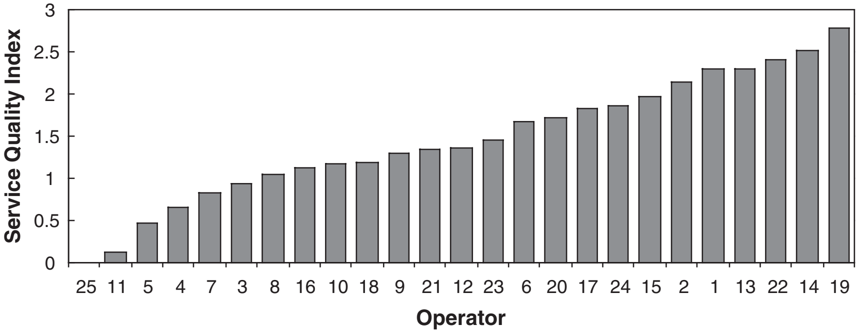


Fig. 21.2. The Benchmarking of Mean SQI across Operators (Operator 25 set = 0).

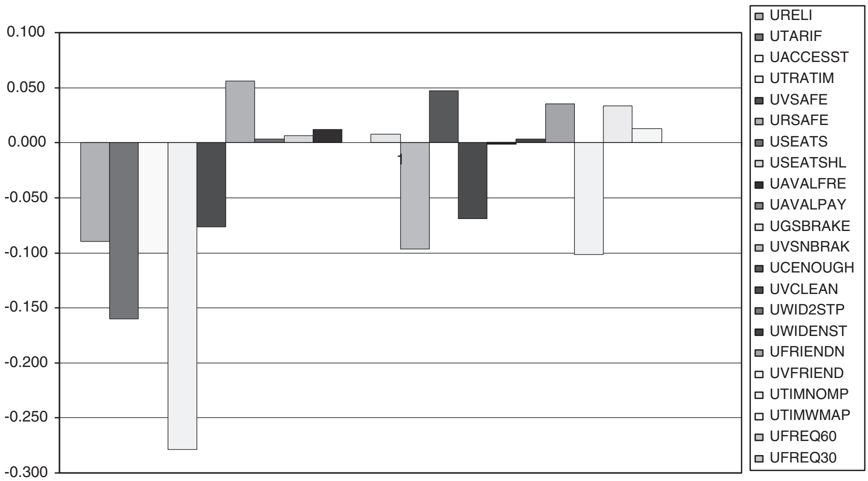


Fig. 21.3. The Composition of the Service Quality Indicator (Difference between Operators 16 and 14).

contrast to the past. We might say that public transport has not done a very good job in securing its future, but has relied too much on government support (explicit or hidden) to get to where it is today. The winds of change centred on institutional reform and cost efficiency have revealed many of the weaknesses of the arrangements of the past and have resulted in some changes that show potential in the long run (but not immediately); however,

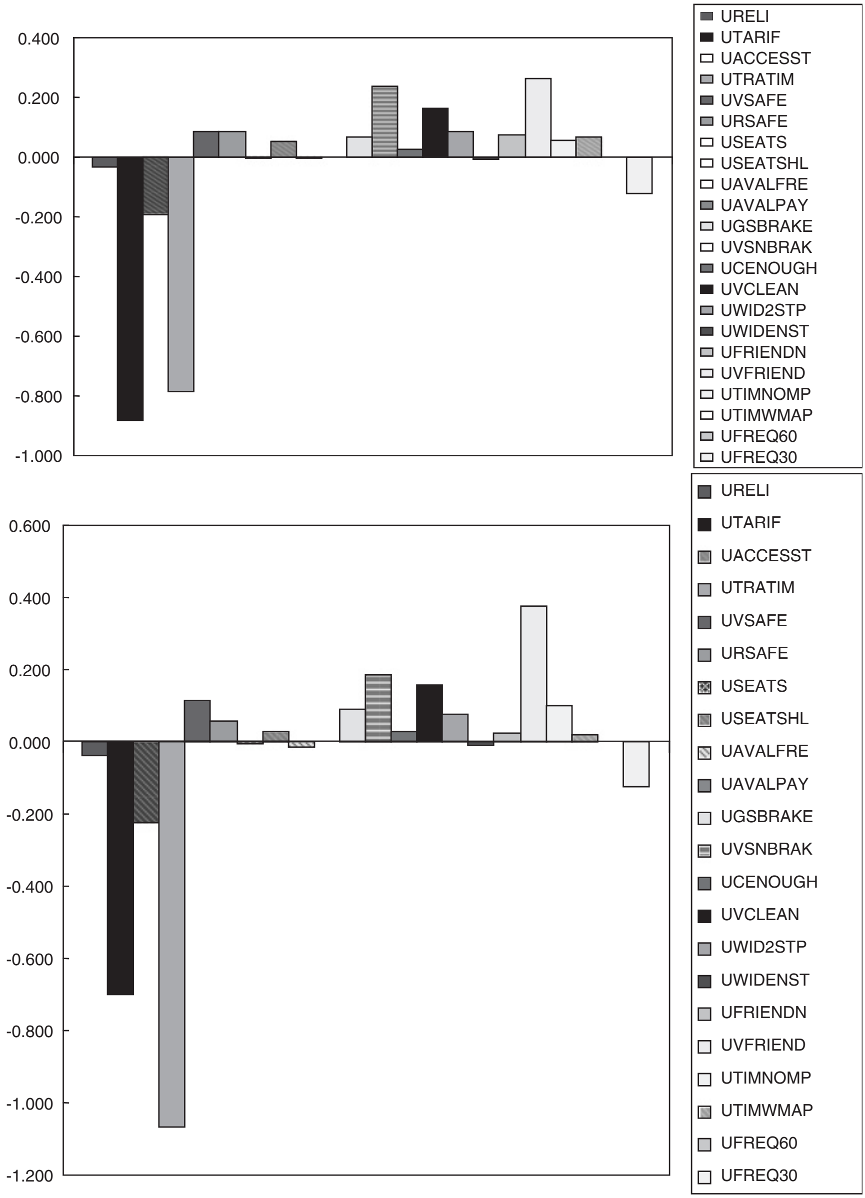


Fig. 21.4. Operator Number 2 versus Best Practice Operator Number 19.

Table 21.8. Notation for Fig. 21.3.

URELI	Late Minutes	UVSNBRAKE	Ride Very Smooth
UTARIF	Bus fare	UCENOUGH	Clean enough
UACCESST	Access time	UVCLEAN	Very clean
UTRATIM	Travel time	UWIDE2STP	Wide entry and two steps
UVSAFE	Very safe	UWIDENSTP	Wide entry no steps
URSAFE	Reasonably safe	UFRIENDN	Friendly drivers
USEATS	Seats only at bus stop	UVFRIEND	Drivers very friendly
USEATSHEL	Seats plus shelter at stop	UTIMWMAP	Timetable and map
UAVALFREE	Free air conditioning	UTIMNOMAP	Timetable, no map
UAVALPAY	Air conditioning at 20% extra fare	UFREQ60	Frequency 60 min
UGSBRAKE	Smooth ride	UFREQ30	Frequency 30 min

we have to be patient since the *repair job* has only just begun. As we come to appreciate the gains from less direct interference from government (and the price being paid by ongoing inefficient interference), but better incentive-based economic regulation, we can start to focus more sharply on the opportunities that exist to position public transport to perform at its peak in niche markets. This is where its future lies. The operators know this but are often limited by external interferences in achieving this objective.[181]

As a closing thought we must continue to recognise that all urban passenger transport is under-priced. Public transport is subsidised heavily by taxpayers while car users impose significant external costs on the community including adverse impacts on air quality as well as on road trauma and energy security.[182] Were prices to be increased for both private and public transport, it is very likely that there would be some reduction in travel across the board and that more efficient land use and transport combinations would result. To this extent, many economists would be aligned with those in the community who consider that there is too much mobility. However, we should not forget what conditions were like before the mobility revolution began; we owe much of what we regard as 'quality of life in urban areas' to our ability to travel. We must remain aware of the benefit side of the equation and not view a reduction in mobility as an end in itself. Policy makers need to be aware that the policy instruments at their disposal to effect a reduction in vehicle emissions involve complex trade-offs and they need to be equipped with tools that help them identify the optimal mix of actions.[183]

Would higher prices necessarily benefit public transport? Consider what impact an increase in fuel tax (directed primarily to the automobile) would have on household travel decisions. The increase in unit operating cost would have an immediate and direct influence on the use of each vehicle for particular trips such as the commuter trip. The outcome might be a shift in the mode of travel, but it could involve substitution within the household's vehicle park. Also, it might affect the timing of the commuter journey. The end result would be a change in the overall and non-commuting use of each automobile available to a household. Given the opportunity to adjust, the household would be likely to consider how many and what types of vehicles to own. Further impacts arise over time as changes in residential location affect the total use of each automobile, as well as the mix of urban (commuting and non-commuting) and non-urban kilometres. The adjustment in commuter travel also may affect non-commuting car use if a vehicle, previously used for commuting, is released for use by another non-working member of the household. The sum effect of the decisions by individual households is a change in the equilibrium levels of traffic congestion, residential densities, total kilometres of travel by automobiles and various forms of public transport, fuel consumed and greenhouse gas emissions. The evidence however is that most of the behavioural response is in rearranging travel in order to avoid the loss of accessibility offered by the car. Public transport is unlikely to be a beneficiary. This is public transport's greatest continuing challenge.

NOTES

1. This regulation pertains to regulate the payment of compensation to transport operators for public service obligations. See van de Velde (2001) for a comprehensive review.

2. Code Napoleon focuses on transport as an input into a wider socio-political-economic framework. It is a device for achieving a range of policy objectives and as such it is argued that the sector should be heavily regulated and controlled by government. The Anglo-Saxon philosophy is that transport is just another sector in the economy that should be provided as efficiently as possible in its own right. Markets are preferred to government intervention and private participation and commercial criteria are dominant.

3. We are now suggesting at any cost since the service level must not suffer by the offer to service at a cost, which is not sustainable.

4. ISOTOPE, QUATTRO, MARETOPE, etc.

5. Given the heterogeneity of the population of bus passengers, segment-specific service quality indicators can be identified.

6. In Cape Town, about 65% of all public transport trips during peak periods are by rail, 20% by minibus-taxi, and 15% by bus.

7. What we see in particular is that the competitive tendering of *a large public sector provider* delivers an immediate cost saving *but it is a once-only gain, with corporatisation sometimes delivering similar outcomes* (e.g., Stanley & Hensher, 2003a, 2003b, 2003c).

> If costs of having a private firm supply the services could be reduced by means of a negotiated contract, the considerable costs of organizing a competitive bidding would be averted. Indeed … a competitive tendering scheme might in some cases be *inferior* to methods of contract renewal or negotiation (Berechman, 1993, pp. 298–299).

8. Some commentators have suggested that this is an example of over-zealous regulators more interested in control (and administrative coherence) than in preserving the benefits of a rich and varied flexible public transport system (often beyond their effective control). This is the price of eliminating a high level of customer service, albeit one out of the control of the regulator.

9. If there was a perfect or near-perfect market for factor inputs (especially capital and labour), then an incumbent should not be concerned since they could sell their assets for their full economic (market) value and be no worse off than if they had successfully re-won the right to deliver services. This is not often the situation however; and indeed the perceptions are such that asset re-investment has become a major concern without substantial guarantees from government or suppliers. Interestingly in Brazil, many operators of urban bus services acquire buses at very attractive prices from the manufacturers and amortise them over 3 years and then on-sell to other markets (in particular poorer border countries). The maintenance warranty over a 3-year economic life is such that the buses often need little attention

and so we see private operators being no more than capital investors. Any incentives to focus on the demand side are conspicuously absent (although with over 60% of market share in favour of bus and rail in metropolitan Brazil, this may be a lesser concern. However, car ownership is steadily rising with a high market share of 80% in Brasilia to 50% elsewhere).

10. In South Africa, CTs are a way to attract new entrants into the market, then based on performance, an extension is negotiated. To attract new entrants, they stipulate a minimum percentage of subcontracting, so that after 1year of subcontracting, the subcontractors can become a 'set aside' and can operate in their own right as a full-fledged operator.

11. Preston, Huang, and Whelan (2003) illustrate the tensions between commercial and social objectives in bus operations which they believe can only be overcome by quality contracts.

12. A setting that has proven to be especially useful within which to position the obligations of organisations and stakeholders is the *STO* framework. *It recognises that* policy, planning, and operations exist within a hierarchy of objectives functionally split into three *interdependent* layers – *S*trategic, *T*actical and *O*perational. This organisational framework offers an attractive setting within which to evaluate mechanisms consistent with a holistic (or system-wide) perspective on service delivery. The main features of the framework are represented by three *STO* levels:

- The *strategic level* where the focus is on the establishment of broad goals and objectives and guidance on ways of achieving outcomes consistent with such goals ('what do you want to achieve').
- The *tactical level* which highlights the supporting mechanisms (e.g., the regulatory process) to achieve the strategic goals. There is a strong emphasis on fare and service planning. In many countries we do not have an explicit public transport regulator and so tactical functions are the responsibility of authorities and/or operators (e.g., Van de Velde & Pruijmboom, 2003)
- The *operational level* which focuses on delivering the desired services to the market consistent with the strategic intent and aided by tactical mechanisms.

Van de Velde and Pruijmboom (2003) illustrate how giving tenderers tactical responsibilities will lead to service uplifts.

13. Although PBCs in developed economies tend to be integrated into a system of subsidy support, this need not be the case in all situations. For example, in Brazil, PBCs are being considered in a context where the operators in the formal (i.e., 'legal') sector would be required to comply with benchmark best practice on costs (without any subsidy support under CSO payments), with fares determined by a cost-plus formula and patronage incentive payments available for patronage growth above an agreed baseline. In Santiago (Chile), an innovative internal cross-subsidy scheme between feeder service operators via a centrally tendered fare collector (using smartcards) is designed to use (feeder) system-wide fare revenue to eliminate all public subsidy.

14. Introducing 'contract components' (MSL, IP, etc.), 'contract form' (how these are combined and measured), and 'contract process' (how components and payment rates are determined – CT, negotiation) was found helpful.

15. The issue of skill enhancement in preparation for participating CT or negotiated contracts is a real concern in many developing economies (e.g., South Africa, Chile and Brazil).

16. We also have a third possible process – competition at the service delivery stage, applied to determine PI payment rates when the budget is fixed, as noted in the text and promoted in Hensher and Houghton (2003). Competition for PIPs therefore, can be an optional complement to both CT and NC. The distinction between CT and NC is blurred to the extent that NCs may be used to determine PIPs in a contract where $CSO is determined through CT, to form a mixed contract. Further, as noted in the text, competition at the service delivery stage may be used to determine PIPs when a $CSO is determined by either CT or NC.

17. Some operators prefer to have a government-determined sum of money available that is not dependent on the success or otherwise of all operators in growing patronage. This is the preferred model promoted by the private operators in Sydney. This model essentially recognises that the competition is between public transport and other modes, especially the car. The challenge is for government to establish a suitable budget to ensure delivery of patronage payments. The Adelaide experience has shown what can happen if the operator is too successful – the money runs out, but the government has a contractual obligation and hence is looking for ways of reducing total payments to operators. Future contracts should learn from this open-ended approach.

18. An increase in patronage may not cost the operator anything, that is, a bus load increasing from 40 to 45 people. It was suggested by Chris Stretch (South Africa) that the incentive should be linked to additional trips and/or additional vehicles are required, although such an approach clearly has drawbacks.

19. There may be other reasons for the regulator to design the service, that is, to address social needs in poor rural areas where the terrain is very hard on vehicles. If an operator designs the service, they may opt for the more lucrative routes and leave people who have no other access to transport, stranded. However, the objective under a trusted partnership is to work co-operatively to avoid this with a clear understanding that such an outcome would not be accepted by the regulator. Indeed such non-compliance is likely to lead to a CT outcome.

20. In some situations such as newly evolving markets, benchmarked costs are required for CT to establish some basis for assessing the ability of the operator to deliver under their offered prices.

21. In Sydney, we have strong evidence that private operators are ‘cross-subsiding’ the contract services that are mandated under MSL conditions for contract compliance, by charter net revenue. This evidence is supportable under generally acceptable assumptions about how shared costs are ‘allocated’.

22. The synthesis of the Santiago plan (known as Trans Santiago) was obtained from discussions in Santiago with SECTRA staff on 24th September in Santiago. I thank Henry Malbran, Executive Secretary of SECTRA, Alan Torres, Technical Coordinator and his staff as well as the regulators from Trans Santiago for briefing me and providing comments on PBCs at a seminar. The comments by Juan Carlos Munoz, Enrique Fernandez and Juan de Dios Ortuzar of the Pontifica Universidad de Chile are greatly appreciated.

23. Part of the reason why the buses are not currently being updated is because the government will no longer guarantee a role for incumbent operators. Indeed it appears that there is a desire to use the tendering process to remove such operators and replace them by a few large operators, preferably from offshore.

24. Indeed the idea of a move to a negotiated PBC with revised benchmarked costings and competition for an above-minimum patronage level budget proposed by the author generated a lot of interest.

25. It is not decided how school children will be handled. In Chile, school children less than or equal to 14 from non-private schools (i.e., 75% of schools) travel for free. Children from non-private schools, 15–18 years of age, are given a school card (distributed by the Ministry of Education), and this entitles them to pay a third of the normal fare in buses. They can also apply to this benefit for Metro trips if they can prove that they live in the vicinity of a Metro station (in this case, they are sold two tickets per day maximum).

26. They are hoping this will not occur as it might encourage some operators to invent fictitious trips to generate a benefit.

27. Importantly, all bidders and SECTRA share the patronage risk and so it could be argued that if there is a shortfall of patronage below forecast levels then SECTRA should agree on some funding arrangement with operators.

28. It is assumed that the patronage incentive payment (while a fixed rate) paid to feeder route operators, on increased patronage, is sufficient incentive to keep up service levels and so no satisfaction survey is required.

29. Readers unfamiliar with the details of competitive tendering will find a useful summary in Hensher and Brewer (2001, pp. 27–34).

30. Integrated fares are not the same as integrated ticketing. The latter refers to the technological platform within which operators provide electronic tickets.

31. Although not the focus of this paper, an important issue is the mechanism for distributing the fare revenue to the transport suppliers, complicated in some jurisdictions by the absence of a 'flag fall' component of a bus fare for each leg of a trip (i.e., a fixed overhead charge per trip regardless of the distance travelled).

32. Australasia includes Australia and New Zealand.

33. An important distinction is made between contract/operator areas that are a single route in contrast to a geographical area. The distinction appears primarily as a matter of shared resources such as depots and co-ordinated timetabling. A review of the literature failed to find a single paper addressing this issue.

34. Although the firm size literature includes direct competition between firms, it also recognises situations in which firms operate as spatial monopolies, as is the situation with bus operators who do not compete in the market (even though they compete with the car).

35. The question not addressed in the literature on bus provision is the extent to which innovative opportunities are greater under regimes, which lessens the power of the regulator in delivery of services. It may be the case that the empirical evidence, as limited as it is, is misleading because of the failure of incentive structures to deliver the gains, which are inherent in a less-constrained market. What we need to understand are the circumstances under which incentives can evolve and be effective.

One problem with the bus industry may be that the lack of experience in managing change and/or the reticence in being innovative given a history of suppression of innovation is hampering the speed of taking up opportunities waiting for action. Generational inheritance, for example, which often lacks an understanding of the need to sustain wealth and survival leads to a reduction in entrepreneurial activity and hence a decline in any potential innovation.

36. The winner's curse exists when the winning operator discovers after winning that it has overpaid given the real value of the tender.

37. All costs are in $AUD, with $AUD1.0 approximately equal to $US0.59.

38. The internal efficiency of an organisation depends on the degree of competition it faces in so far as competition affects managerial incentives and opportunities. One way that competition sharpens incentives and hence internal efficiency is by permitting the relative performance of agents to be compared. Benchmarking runs the real risk of being lost with a very few operators.

39. In Oslo, there is currently discussion about the contract size for the future bus tenders. The authority has clearly stated that operators should be given financial incentives for passenger growth and service quality, and performance contract principles should be applied. The problem here is that there are two principal agent relationships. Firstly, there will be a contract between the city and the municipal company (Oslo Sporveier) that serves as the PTE. This will be a network-wide net contract which will not be tendered. Previously, this relation was subject to a performance-based subsidy, but this has been discontinued. Secondly, there will be tendered sub-contracts for various packages. These are the contracts for which performance-based principles will be applied. (Both net and gross contracts are currently in use for these operations, but tendering has not yet commenced.) To ensure a sufficient number of competitors it is expected that the PTE will want to restrict the size of contract areas. In practice, this will mean that the tender packages will consist of a small number of routes. The Oslo network is complex and routes criss-cross all over the city. Consequently, they may be difficult to implement net-cost contracts, at least without a sophisticated revenue allocation system. The alternative is a gross-cost system with quality incentives, but that is something different from the Hordaland type model, which requires a net cost contract.

40. Although not specifically related to number of operators, the issue of who owns what is very important in determining economic efficiency in service delivery. Operating franchises such as those in Adelaide that separate investment from operating decisions are "bound to result in resource misallocation, manifested by over-capitalisation and the production of dispensable and under-utilized services" (Berechman, 1994, p. 294). Apart from the diverse goals of the owner of the assets (i.e., the public sector) who promote social welfare outcomes in contrast to the commercial outcomes of the operator, the government and operator disproportionately share the overall risk since the bulk of the risk associated with capital investment (notably the fleet) is assumed by government. With the risk of over-capitalisation greater than under single ownership (and a single commercial objective), the loss of economic efficiency is very real, exacerbated if the operator engages in higher risk projects than they would otherwise do so if they carried the full risk. This risk can in part be circumvented by monitoring but at a much higher level that would be required if the operator carried all the risk. But it is doubtful that the government would be able to acquire all the

necessary information on costs and demand without outlaying a lot of resources. The transactions costs are likely to raise questions about the value of this approach to service delivery. Under risk-sharing the notion that bidders are expected to bear the entire risk stemming from investment and operational decisions with the face value of their bids serving as a sound predictor of their expected performance, evaporates.

41. "If costs of having a private firm supply the services could be reduced by means of a negotiated contract, the considerable costs of organizing a competitive bidding would be averted. Indeed … a competitive tendering scheme might in some cases be inferior to methods of contract renewal or negotiation" (Berechman, 1994, pp. 298–299).

42. Within the Sydney metropolitan area, the private bus operators are some of the most cost efficient in the world. Consequently, competitive tendering in very unlikely to deliver financial benefit.

43. There is a case for economies of scale in moving from a very small operation such as 1–4 buses up to about 30 buses, but over the range 30–100 we see almost constant returns to scale with decreasing returns to scale over 100 buses (Berechman, 1994 and personal communication (July 11, 2002) with Kjell Jansson, Sweden). Fleet size is an appropriate indicator of scale, being highly correlated with other contenders such as population per square kilometre (a correlation of 0.886 for the STA contract areas). Other indicators such as area (in square kilometres) has a simple correlation of –0.80 for STA areas.

44. The Sydney 2000 Olympics provided valuable evidence on this matter (Hensher & Brewer, 2002). The depot set up to co-ordinate bus services accommodated over 1,000 buses, substantially larger than the largest depot in Sydney under normal conditions (an STA depot with 250 buses). In hindsight it was concluded that major internal efficiencies could have been obtained by having a series of smaller depots up to 150 buses.

45. We would argue that this is common in most large metropolitan areas.

46. Research by Alsnih and Hensher (2003) suggests that seniors and the elderly (i.e., individuals over 55-years old) are less inclined to use public transport where transfers are required.

47. It has been pointed out to me that the examples of cross-regional services in the text are very weak because they do not involve picking up and dropping off in more than one contract area. (The CBD of Sydney is not a contract area.) This ability does not exist among private operators in Sydney because of the existing contract requirements. It is suggested that the government operator (State Transit) has true cross-regional services such as Route 400 (Burwood to Bondi Junction), Route 370 (Coogee to Leichhardt), and Route L20 (City to Parramatta). The private operators have not to date developed strategic alliances to pick up and drop off in more than one operator's area, denying themselves of alliance revenue.

48. Although the automated fare collection (AFC) system of the STA shows that one in five boardings is made by a Travelpass ticket of which 66% are a train + bus + ferry ticket and 32% are a bus-ferry ticket (with only 3% being bus only), it is unclear as to whether the ticket purchaser actually uses more than one mode or is simply taking advantage of the attractive discounts offered. For example, the average discount on travelpasses is between 27 and 36%.

49. The inequity is likely to arise from cross-subsidy to the relatively wealthier travellers who tend to undertake the longer trips.

50. The introduction of integrated fares is often in conjunction with other measures, such as increased marketing budgets to push the new ticketing and promoting bus travel, better information systems, increased bus frequencies, and discounts to fares. Increased discounting would be a feature of many integrated ticketing exercises and would have an impact on ridership.

51. One referee suggested that "The Appendices definitely demonstrate increased ridership in cases of fare integration". While not denying the absolute evidence, the text herein argues that the contribution of fare integration to the patronage increases is by no means clear and that other factors have played a role. We support a much more carefully constructed empirical study to establish the wider set of influences on patronage increases rather than credit it all to fares integration.

52. Although congestion (as an intra-sectoral externality) is typically the largest single externality in terms of total cost, it is not the only cost and inter-sectoral matters of health and safety are essential elements of an environmental improvement package. In BIC (2001), congestion costs only accounted for 42% of total external costs of road use in Australia.

53. A potentially relevant matter of detail is to establish rules for handling switchers from environmentally friendly modes such as walking and cycling. While this might be a valid inclusion in the user benefit component, it might be argued to be a loss of positive externality. We would argue that it is unlikely that many walkers would use a bus for the line haul but they may for short trips to interchanges such as railway stations. Interestingly, this growth in bus patronage might be what is needed to justify new services for others to benefit from (a threshold argument). On balance we argue that some approximations must always be made for any regulatory regime to function administratively. These niceties of theory may well have to remain as just that. On balance it is assumed that it is a good thing to generate extra bus passengers. In the 1970s in the UK, maximisation of passenger kilometres was shown to be a very good surrogate for maximisation of social welfare (Beesley, Gist, & Glaister, 1983).

54. A factor that has driven business consolidation in the British bus sector is the long-term advantage in securing very high market share in a region (Roberts, 2001).

55. Market knowledge is more than simply having data from electronic ticketing (which in time will be increasingly available to regulators). It also involves a much more intimate local knowledge of the population and historical evidence on what service changes have worked or not worked.

56. It is the operator's responsibility to grow patronage in any way possible, but we must establish unambiguous rules that establish what is actual patronage growth. For example, an increase in boardings achieved by re-designing the network to force bus-to-bus transfers to complete a trip might be argued to not be patronage growth but simply the same individual having to double their boarding without increasing their trips.

57. Some counties in Norway have adopted tendering systems while others have continued with conventional negotiation schemes. In Sweden, there is some critique of the widely used tendering/gross cost contract model (London model), although few truly innovative alternatives have emerged. In Denmark, a similar model is used,

notably in the Copenhagen region, but there is opposition against tendering regimes, notably in Aarhus, where the municipal operator and the authority have opposed tendering in favour of a benchmarking-inspired model. The Norwegian Ministry of Transport and Communications are currently incorporating performance-based elements in their contracts with Norwegian State Railways.

58. The inclusion of a MSL in a PBC may appear to be a contradiction since it is likely to impose a specific rigid timetable and network. In part, this may be true (given historical interpretations of MSL), but we would prefer a looser interpretation of MSL being simply a minimum amount of service vehicle kilometres. One might reasonably expect an operator to respond under MSL with a profile of operating hours, frequency, average age of vehicles, fare concessions, and accessible vehicles (associated with a minimum revenue VKM) to be approved by a regulator but not to be a very precise requirement.

59. There is a growing concern in England that concessionary fare subsidies are not matched by appropriate 'deliverable and measurable outputs' (Department of Transport & Regions (DTLR), 2002). The Director-General of the Greater Manchester Passenger Transport Executive stated in a submission to the House of Commons Transport Select Committee's inquiry on the bus industry that "We would like to reach a point where all the money paid to the bus industry is linked in some way to outputs". The most interesting feature of the reform proposal is, over a 3–5-year period, to transfer some or all of the concessionary fares budget into a central pot. Operators would then be asked to come forward with proposals for delivering a network of commercial and supported services determined by the central authority and 10 metropolitan governments. This has been described as "voluntary quality contracts" that push at the limits of quality partnerships but which is necessary to improve the increasingly poor quality of service levels of bus provision (which has evolved out of economic deregulation and competitive tendering of non-commercial services).

60. Although competitive tendering of PBCs is always possible, if it were introduced it must be based on a selection system that involves service quality criteria rather than the conventional minimum-cost criteria in most non-PBC tendering processes (i.e., the 'lowest price wins'). Telemark County in southern Norway has recently adopted this model, although it is too early to see how it compares with PBCs per se. The ability to optimise system-wide social surplus still remains a challenge, however. In discussions with Carlquist, he supports the position taken here that a tendering system (be it a lowest-price based bidding or a quality-focused approach) will have difficulty in controlling the system-wide allocation of funds. His team at the Institute of Transport Economics in Oslo will be investigating this issue if Telemark County accepts their proposal for a research project. Carlquist comments that "Currently it seems that elements of PBC may be incorporated in the quality tendering system ("QTS") in the sense that the best quality bid within a given financial limit will be accepted, but that there is a considerable degree of freedom within that limit, defined by various incentives. I must admit that we currently do not know exactly how to sort this out …" The contention of the current authors is that competitive tendering on single contracts cannot deal with this problem of social optimisation at an area-wide level, where multiple contracts are involved across the area.

61. A commentator suggested that: "Reform of contract areas is a key issue in any reform of bus service regulation. … It is generally recognised that in Sydney, areas

are too small, and service provision would benefit from amalgamation. There would also be benefits to the regulator in implementing PBCs if areas were bigger, and fewer operators to deal with". This is an issue of great sensitivity in the debate on bus reform in NSW. It implies that opportunities for operators to co-operate (even form strategic alliances such as the very effective one in Perth across three operator contract areas to offer an orbital service) cannot be achieved and hence we have to have large contract areas operated by a single operator. The Mohring effect, which promotes benefits on the demand side from increased network integrity says nothing about this only being achievable by larger contract areas. Given constant returns to scale on the supply side, the real risk is that amalgamation leads to cost increases and pressures on government to provide increasing levels of subsidy to pay for quasi-monopoly rents and featherbedding. What we need is incentives to do this through contract area alliances. PBCs are the instrument.

62. Hordaland is a County in Western Norway and includes the city of Bergen. The total population is 450,000. There were three major operators delivering in 1999 about 24 million revenue kilometres per annum and carrying 35 million passengers per annum. Total annual deficit is 170 million Norwegian Kroner.

63. Specifically, in the Hordaland model, vehicle kilometres, vehicle hours, and passenger trips (differentiated between peak hours and normal hours) are all part of the subsidy calculation and are not related to the MSL as such. The total level of subsidy must at least allow for the fulfilment of the MSL obligations. The VKM-based subsidy primarily reflects user benefits of increased frequency rather than MSL. In the Norwegian model, the MSL is given as a contractual obligation, and technically speaking the subsidy per vehicle kilometre is not offered for the MSL as such. Rather, as in the Oslo model, additional vehicle kilometres and additional passenger trips exceeding a base level are compensated for.

64. Details of the nature of the survey, its content and regularity is not mentioned in the reports. Hensher and his colleagues have developed a monitoring system centred around a service quality index (SQI) that can separate out service quality issues that are directly under the control of the operator and those which the operator has little if any control over. See Hensher et al. (2003, and Chapter 14) for further details.

65. While it is a good idea that payments are higher for peak period, patronage increases, many of the public transport improvements that would make a difference in reducing road congestion in those congested inner city areas are out of operators' hands and could be capital intensive (not just operating costs) e.g., bus priority, banning vehicles in the CBD, introducing cordon pricing, These external strategies that can assist patronage growth are part of what we call the quality partnership initiative that is assumed to occur once appropriate incentives are in place to grow patronage. It is a reasonable presumption that government would support such initiatives if they grow patronage and add value for money to overall government commitment.

66. Ian Wallis has provided further clarification: the roading hurdle rate is incorporated into the public transport (PT) payment formulation. The roading hurdle rate is first adjusted for the lower risk of patronage funding (i.e., based on outcomes rather than forecasts). PT user benefits have been divided by 4 before being added to the externality benefits, with the total being divided by the hurdle rate. Wallis describes the factor of 4 as purely a political decision, although our understanding is

that the value 4 is the marginal benefit-cost ratio from road projects. If it were not included, in general the PT user benefit term would dominate the total PT benefit measure. The Norwegian experience is an interesting contrast: Carlquist advises that large patronage growth has not been an issue in Norwegian contexts so far as almost all PT markets have a fairly limited growth potential. However, there has been large patronage increases for some of the interregional express buses, but these networks do not receive subsidies as they are considered 'commercially viable'. These networks do indeed produce profits for the operator, but as there may be further potential user benefits due to frequency increases, or other externalities, there could still be a rationale for subsidising these routes, and thus the patronage growth problem could become reality. In practice, however, Carlquist is quite sure that the subsidies will be allocated mostly to those local (urban + rural) networks plus the railway networks where there is a minimum service requirement and limited demand – for political reasons. Thus there has been no need for hurdle rates like in New Zealand so far. But as illustrated in Carlquist's Hordaland paper there do exist maximum levels ('ceilings') of total subsidy payments. He comments in a personal communication (15 May 2002) that: "Ironically, in my opinion, these maximum levels are often too low to really justify a PBC regime!"

67. Ian Wallis says that in practice it could be claimed that it does, by taking the existing situation (service levels, fares, and funding) as the MSL/CSO baseline. However, this begs the question of whether the starting point bears any relationship at all to a cost-benchmarked MSL or is simply the result of years of history.

68. While it can be claimed that competitive tendering can accommodate the same set of contract-specific incentive payment rules, including MSL/CSO conditions, there is no mechanism able to ensure that the total subsidy available (inclusive or exclusive of the CSO payments associated with MSL) are optimally distributed. The PBC framework which avoids the need for tendering of a lot of contracts (over 300 in NSW) has this capability (as shown in Hensher & Houghton, 2002 and Chapter 7). It is unlikely that all contracts can be renewed through competitive tendering at the same time so that the regulator can assess the budgetary implications and the optimal distribution of financial support. Reducing the number of contract as to a handful (as has often been stated) is not a solution since it carries many other concerns about market performance and price escalation.

69. In the Hordaland model, two different effects of new passengers exist: One (negative) is more crowding, increasing passengers' travel time value (less chance of getting a seat, less space) and overall travel time (increased loading times, which also increases operators' costs through reduced speed and dimensioning of vehicles). The other (positive) is the improved service level in response to higher demand, which provides all passengers with higher service frequency or more routes.

70. The Norwegian model includes only the external costs of traffic congestion in the externalities. They regard the costs of accidents, pollution, etc. as internalised in fuel taxes. Furthermore, external congestion costs/benefits of modal shift only applies to larger conurbations and in peak hours. Due to relatively low subsidy levels in Hordaland, the new regime has not brought about any dramatic changes. Nils Fearnley (ITE, Norway) suggests that it is probably too early to evaluate the new scheme because its success rests upon longer-term decisions in the operator, like fleet size and composition.

71. In the first instance, to establish an optimal incentive payment regime given the $CSO commitment and the overall subsidy budget cap, we have to make as informed a judgement as is possible on the percentage of switchers from car. Once the PBC system is in place, the source of modal diversion should be identified by some sample survey, which might be undertaken and funded on behalf of the regulator by an independent organisation. Such a survey would be relatively inexpensive since it would involve a few questions from an on-board survey. Our recent experience with a much larger on-board survey to measure service quality showed that the involvement of the bus company in distributing and collecting forms under a sampling scheme designed by the Institute of Transport Studies worked very well and was very cost effective (Hensher et al., 2002).

72. Although readily available, we recognise that some items such as elasticities may be controversial, yet in practice a set of starting values will have to be agreed to.

73. For example, at a presentation of the theme of this paper at the Warringah Council Civic Centre (Northern Beaches area in Sydney) on 22 May 2002, in closing the session the Mayor of Warringah (Darren Jones) suggested that the Sports facility at Brookvale could have a parking station under the oval which would serve as a park-n-ride interchange for a high-frequency bus service (almost a subscription service) to and from the two main locations outside of the Warringah peninsula (namely North Sydney and the City). We promoted the idea jointly of a quality contract partnership between the Council (owners of the oval), car park developers, and the government bus provider to deliver this door-to-door transport capability such that the risks and rewards are shared. Parkers using the bus service might be given heavily discounted secure parking that is cross-subsidised by parkers who do not use the bus service. A portion of the revenue from parking might also be hypothecated to public transport improvements.

74. Jan Owen Jansson in his plenary paper at the 7th International Conference on Competition and Ownership of Land Passenger Transport (Jansson, 2001) states:

> Two main possibilities for improvement [in cost efficiency] are to stimulate competition, and to enhance the motivation and creativity of operators by introducing the profit motive into a traditional 'public service'. The question is, if the present allocative inefficiency in transport markets will be improved in the process, it is argued that these changes will not be brought about by the increased reliance on market forces. On the contrary, better planning of public transport systems, and, I dare say, continued or increased subsidization are two necessary conditions for realizing the potential improvement of the resource allocation. A complementary, significant point is, however, that there is no inevitable conflict between the ambition to increase cost efficiency in public transport, and a transport policy towards an efficient modal split.

75. An area that includes the city of Bergen as well as some surrounding rural areas.

76. Competitive tendering as implemented, in contrast, has mainly focussed on sharing the costs of inputs.

77. Although the principal modal choice in the Hordaland context is between bus and car, the competition can be generalised to include rail, ferry, etc.

78. Strictly, CS is the sum of private user benefits (UB) and (internalised) environmental benefits (EB), but herein we treat them as separate benefit sources, referring to private user benefits as CS.

79. It must also be recognised that the delivery of positive CS under a subsidy-scheme recognises the presence of under-pricing of competing modes such as the car. Subsidies to public transport are designed to bring its operation into line with social considerations. In particular, when car users are not charged for the negative externalities that arise from their car use, subsidies for bus services can help to encourage travellers to make appropriate choices between travel modes. Yet, when privatisation and contracting-out of bus services came into vogue in the mid-1980s, the principal aims were simply to reduce subsidies and to increase cost efficiency. In recent years, the focus has turned to the shaping of payment instruments to try to secure behavioural responses that support the specific policy purposes of the government instrumentality that pays the subsidy.

80. This is separate from any operator commitment to internal cross-subsidy between various activities that is consistent with efficiency objectives provided that avoidable costs are covered on each (well-defined) activity.

81. We recognise that monitoring of performance cannot be precise and must be dependent on trust and quality reporting (Carlquist, 2001). Such a monitoring program should focus on the three dimensions of overall performance: cost efficiency, cost effectiveness, and service effectiveness. The role of constructs such as a Service Quality Index (SQI) developed by Hensher and his colleagues (e.g., Prioni & Hensher, 2000; Hensher & Prioni, 2002; Hensher et al., 2002) offers one way of tracking the last dimension. A referee also made excellent suggestions on the ex ante requirement for relevant information on costs and demand conditions with ex post monitoring.

82. The evidence is drawn from Carlquist (2001); Larsen (2001); Johansen et al. (2001); Mills and Gale (2002). Hensher and Stanley (2002) provide further details of the Norwegian model and the arguments for PBC compared to CT. We recognise however that a PBC framework can also be implemented as part of a CT regime.

83. As an example of the subsidy calculation, using vehicle kilometres (VKM) as the performance criterion and \$/vkm as the cost rate (RATE), with the subsidy subject to a maximum predetermined level, the subsidy in year $t = (RATE^{*}VKM_t)$ minus a fixed deduction as explained in Larsen (2001). Profits are co-determined by different performance-based items – ticket revenues (I), subsidies (S), and costs (C). Ticket revenue is equal to fare (F) multiplied by demand (D), and demand is a function of VKM, fares and other service attributes. That is: profits $= I+S-C$, $C = f(VKM)$, $I = F^{*}X$ and $X = g(VKM, F, \ldots)$. Given the right incentive (i.e., RATE) the operator will decide on a fare level and VKM at a level that maximises profits and maximises social welfare given the budgetary limits for subsidy support. The budgetary limit is often associated with a constrained social welfare maximisation rule (or Ramsey rule) that implicitly imposes a marginal cost of government funds on the calculation (i.e., the amount that government is willing and possibly able to contribute to the social welfare objective).

84. The global budget constraint is a very important parameter for the NSW government because it is at the heart of the Bus Reform agenda. The intent appears to be clear – to provide increased value for money within a system-wide pre-determined maximum budget. As detailed herein PBCs can be developed for transition (holding existing subsidy levels fixed) and then later allow the subsidy level to vary as the reward for growing patronage.

85. A referee pointed out that the operator is not responsible for all actions in growing patronage and securing an acceptable return on investment. We agree with this point. As discussed in more detail in Hensher and Stanley (2002 and Chapter 6), the regulatory regime should be focussed on providing a socially responsible environment in which operators seek to deliver cost efficient services (through careful selection of all inputs – types of vehicles, labour support, etc. as well as service levels (frequency, coverage, fare structure, and discounts, etc.).

86. And certainly no increase over existing regulatory resource commitments.

87. Although we specify MSL in terms of a minimum amount of revenue VKM, the regulator may wish to impose some very specific conditions on where and when these RVKM are to be provided within the contract area. This is not an issue of concern to establishing the appropriate level of incentive payment, given a system-wide subsidy budget, since all we need to know is the minimum RVKM for each of the peak and of-peak periods for each contract area. We have doubts about the benefit of imposing too rigid a service specification, as is currently the situation in NSW, because it results in many services with very little patronage and substantial cost-burdens, that do not provide real benefits to society. Spreading thin resources thinly is not a virtue that we should promote. Larsen (2001, p. 2) promotes a view that " … the design of a route system is best left to an operator familiar with the area to be served". There are sensible reasons for moving, from the tactical to operator level, the fare structure, fare level, route networks, and timetables, within the parameters of the incentive-driven quality contract.

88. In the Sydney context, accumulated experience with tendering (e.g., nightride contracts, Transitway operations) and with operators bidding in other urban areas in Australia (especially Perth and Adelaide) has provided a rich reference for best practice costs. A referee suggested that competitive tendering is an appropriate first round setting in which to establish costs to be used in subsequent rounds when practising PBCs. We support this where the incumbent is a public operator or a poorly performing incumbent; however in the Australian context we have observed that after the initial CT rounds, the gains in cost efficiency are quite marginal as long as the incumbent operator continues to operate at contract costs (see Bray, 2002).

89. If there is a case for differences in cost efficient rates (for whatever reason, such as an equity-adjustment), this can be included.

90. A passenger trip is defined as a single one-way trip from an origin to a destination. If a transfer between buses is required this is not two passenger trips.

91. An MSL is not a necessary input into the determination of a PBC, but we include it as a specific input given that the regulator may require its inclusion. Hensher and Houghton (2005c) show what the implications are for determining the maximum SS solution when there is no MSL.

92. This percentage is derived from the percentage of RVKM complying with MSLs for the illustrative operating context from which the data are extracted.

93. Specifically, R controls the structure of the contract scheme. Defining $\%PBC = (1–R)$, $\$CSO^*(1–R)$ gives the MSL component of the subsidy; and hence the subsidy applied to the performance incentive is $TB–CSO^*(1–R)$ The RVKM required to meet the (reduced) CSO is VKM $\times$ 67(1–R).

94. This cap can be applied to specific locations if that is more politically palatable. For example, in the Sydney metropolitan area, the government may choose to treat the government operator (the inner area supplier) differently to the private (outer area) operators. In addition, government may wish to pre-assign a cap to each operator (which we would recommend in the transition phase but not in post-transition growth phase).

95. Given by $Y^{MSL} = Y^B \exp\left[\varepsilon_Y^X / X^B (X^A - X^B)\right]$.

96. Eq. (7.13) adds $P(CS+EB)$ and $\$CSO(1–R)$ to the social surplus expression as they constitute part of the producers surplus, and then they are both subtracted since they sum to the scheme cost.

97. This assumption can be refined by an assessment of source of switchers in the first monitoring period of if other evidence is available.

98. Where the growth in bus patronage impacts noticeably on levels of road damage, congestion, etc., the incremental external costs should be set off against the benefits from reduced car use. The comments of a referee are appreciated. A referee also suggested adding parking subsidies as an external cost. While there is merit in considering this, despite some views that it is bundled with private transactions and borne by businesses, parking is not an issue in the context on the outer-urban application in Sydney. It would be for inner-urban applications.

99. EB may be negative if passenger trips fall and they switch to car, although we are not proposing to tax the operator.

100. We used the data from 12 operators to confirm benchmark best cost practice and then used other data from this operator as if they were the system-wide provider. This paper does not assume anything about the optimum number of contract areas or operators. This issue is detailed in Hensher (2002b).

101. Establishing the correct %MSL in the transition period is crucial. It determines the \$CSO commitment and hence the residual TB available for incentive payments.

102. There is growing concern in England that concessionary fare subsidies are not matched by appropriate ‘deliverable and measurable outputs’ (DLTR, 2002). The Director-General of the Greater Manchester Passenger Transport Executive stated in a submission to the House of Commons Transport Select Committee’s inquiry on the bus industry that “We would like to reach a point where all the money paid to the bus industry is linked in some way to outputs”. The most interesting feature of the reform proposal is, over a 3–5 year period, to transfer some or all of the concessionary fares budget into a central pot. Operators would then be asked to come forward with proposals for delivering a network of commercial and supported services determined by the central authority and 10 metropolitan governments. This has been described as ‘voluntary quality contracts’ that push at the limits of quality

partnerships but which is necessary to improve the increasingly poor quality of service levels of bus provision (which has evolved out of economic deregulation and competitive tendering of non-commercial services).

103. Benchmark operators (as we have analysed in the case study) claim all of the subsidy budget by moving to their existing (developed) position. But lesser operators will be more seriously influenced by the percentage of PBC in the scheme. At 1%PBC, 1%TB is spread over service levels from 99%MSL to MSL+ development potential, and the lesser operator is unlikely to be much influenced to change. Consider, therefore, an increasing %PBC, where the increase is staged in a way that allows adequate time for operators to progressively improve efficiency as the scheme moves increasingly further away from the status quo. The final position would be 100%-PBC over the range 0% MSL to the full development potential. Hensher and Houghton (2005b,c) present this range of opportunities.

104. Co-founded by David Hensher and the late Professor Michael Beesley, and now recognised globally as the premier conference on competition and ownership of land passenger transport.

105. This phrasing avoids the ambiguity of subsidy since government is also investing in the system.

106. We often are told that the incumbent tends to win back the tendered contract. If this is the case then why are we undertaking tendering instead of seeking out efficient solutions through negotiated performance-based contracts (see Hensher & Houghton, 2004, 2005a)?

107. It is true that there are plenty of examples of mistrust that lead a loss of performance (e.g., aspects of the UK rail regulatory regime and the operator collusion that occurred in France – see Yvrande-Billon (2006) – the latter linked to lack of expertise within the public authorities); however this should not be read that the 'solution' lies in competitive tendering, but in a better aligned trust chain conditioned on clear contractual obligations, incentives and non-compliant conditions.

108. Often with assumed Grandfather's rights.

109. I am reminded of what happens when a private plumber as a service provider services one's hot water system. One does not argue that the equipment he uses, which I am paying for in part, belongs to me. It is capitalised in the price charged and he keeps the equipment. So why should not the cost of a transit service provided by an operator be treated the same (as the cost of providing a service), with the service charged back to the government through a funding model? Indeed even if one goes to competitive tendering, this should apply.

110. The Adelaide and Perth success under competitively tendered management contracts appears to be due in the main to the patronage and service incentive payment schemes and not tendering per se (except in the initial round of moving from public to private service provision). It is also noteworthy in a growing number of countries that the average number of bidders is declining. For example, the average number of bids per route tender in London is currently 3 but was 4.5 in the late 1990s. One would expect more interest in less risky route-based contracts. For area wide contracts in New Zealand the average number of bids is 1.2 with the incumbent winning nearly 90% of the contracts.

111. Operators in Sydney have to apply to the Government for permission to purchase new vehicles, and the Government will decide if this is supported. The operator will then offer quotes from suppliers, and the Government will choose one and provide funding over the life of the asset. The asset life is government determined, in contrast to allowing an operator to determine the write off period according to the financial state of their business. A related matter that arises when determining the cost of capital is the opportunity that exists for either party to recognise ways in which one party might have a comparative advantage in the ability to raise capital to fund assets. This will depend on the performance rating of a specific government (AAA, etc.), the taxation regimes in place for private and public sector loans and interest rate cycles. Importantly, the source of funds can be treated in such a way that the party best placed to get the most attractive financial deal for the sector can then make the assets available to the operator (unless the operator is the best financier), at an agreed price, without having ownership transfer along the lines being implemented in Sydney.

112. Hart and Moore (1990) show that this provides incentives to act in the asset owner's interests.

113. For example, when a private operator does not invest in service planning and employs lower quality tangible and intangible assets. The 'power' of incentives must be looked at in 2 dimensions: Current income – flat fee (lowest) through to entirely performance-based (highest); and Future income – No chance of losing contract (lowest) through to certainty that contract will be lost if performance is in any way sub-standard (highest). This is more complicated where bonuses or contract renewal depend on the subjective assessment of the principal. These incentives are generally considered to be relatively low-powered (if performance criteria are unknown they are ignored, although you would expect the agent to have some idea). We certainly see subjective assessment in the Sydney contracts (e.g., operators are required to "work cooperatively with neighbouring service providers" – how is this assessed?). In the bus context, government ownership provides low powered incentives as there is little threat of termination and current income is often not related to performance. For private operators, examples of contractual elements that contribute to the overall 'power' of the contract include: contract length (longer contract, lower powered), relative size of performance payments (less performance-based, lower powered), KPIs and other explicit measures of performance (less extensive, lower powered), contract renewal clauses (automatic renewal, lower powered), clauses relating to the transfer of private information (easier to hide poor performance, lower powered), clauses relating to termination/replacement with another operator (harder for principal to terminate contract, lower powered).

114. For example, in New Zealand's two largest centres, Wallis and Hensher (2005) point out that most tenders now have only one bidder.

115. The average number of bids per tender in Auckland is 1.33 (with 83% won by the incumbent), and 1.12 in Wellington (with an incumbent success rate of 88%).

116. Russell (2000, Table 4). This table shows $1.82 billion expected savings over four metropolitan franchises and one regional franchise, presumably in 1999 prices (the price levels were not indicated in the report). Making an allowance for varying

lengths of franchises, the expected annual saving would be of the order of \$160 million.

117. The 'Fixed' payments in this figure include the net of fixed base operating subsidy, infrastructure lease payments and payments for commercial sites. 'New investment' includes new investment in rolling stock and other capital grants. 'Performance' payments include the variable elements of concession fare payments, patronage growth incentive, operational performance bonuses/penalties and other service payments.

118. Victorian Auditor General, Public Transport Reforms: Moving from a Service to a System, Report No. 5, May, 1998, p. 1. Capital outlays of \$332 million were also incurred, together with a cost for accelerated superannuation of \$453 million.

119. Victorian Auditor General (1998, p. 1).

120. Victorian Auditor General (1998, p. 8).

121. The Australian Financial Review (18/12/2002, p. 54) suggested a figure of about \$335 million, other press comment suggesting even higher figures.

122. Source: Department of Infrastructure, Track Record, Numbers 3 (2000) and 13 (2003).

123. Department of Infrastructure, Track Record, Numbers 3 (2000) and 13 (2003).

124. See, for example, Ross (2003).

125. A paper by Wallis and Gale (2001) to the Thredbo 7 Conference in Norway illustrated the application of an approach along the latter lines.

126. Because most bus services in Melbourne were started by private operators and run for many years from the farebox, the bus industry has long argued that operators have a legitimate equity interest in the bus routes they initiated, even though government now subsidises service provision. This position has been successfully defended in the court system in the past.

127. Although the levels vary widely, the great majority of cost overruns are in the 10–40% band but some notable exceptions are well above this range, such as Boston's artery/tunnel project (196%), the Humber Bridge (UK) (175%), the Shinkensen Joetsu rail line (100%), the Channel tunnel (80%), the Paris–Auber–Nanterre rail line (60%) to name but a few examples.

128. Note that the MNL model predicts random choice when $\lambda \rightarrow 0$, and approximates a step function for the alternative with maximal utility as $\lambda \rightarrow \infty$ (see Ben-Akiva & Lerman, 1985). This general behaviour applies to all choice model specifications.

129. This is a case of Schwarz's theorem: if the mixed partial derivatives $\mathrm{d}f/(\mathrm{d}x\,\mathrm{d}y)$ and $\mathrm{d}f/(\mathrm{d}y\,\mathrm{d}x)$ are themselves continuous functions of x and y in a domain D then they are equal to each other. Or simply, if the utility function is differentiable at least to the third order then the matrix of second order derivatives (the Hessian) is symmetrical.

130. For simplicity, non-negativity is imposed rather than setting an arbitarily small positive lower bound.

131. Each altered element is effectively drawn from four elements in matrix **K**. The two diagonal elements from the share weighted column sum condition, a symmetrically dependent element from the above diagonal set and its own,

corresponding, element. When function f is expanded each squared term for the elements to be altered has a coefficient of the following form,

$$\frac{1}{sd_i}\left[\left(\frac{w_j s_j}{w_i s_i}\right)^2 + 1\right] + \frac{1}{sd_j}\left[\left(\frac{s_i}{s_j}\right)^2 + \left(\frac{w_i}{w_j}\right)^2\right]$$

which is non-negative.

132. The Glaister and Lewis (1978) estimates are expressed as compensated elasticities but they do not differ appreciably from the ordinary elasticities.

133. Typical service specifications vary from country to country and indeed even by contract. In Britain a typical service specification is an exact timetable or at the very least a frequency by time of day with the first and last bus times specified.

134. These words are carefully chosen and reflect the feedback from scheduled route operators in NSW who participated in the survey and who are looking for ways of monitoring and benchmarking their performance from a user perspective. The sample of operators indicated that the information identified via the SQI method presented herein is very useful as a platform for comparing their performance with other operators and saw the data collection exercise as straightforward. Model estimation was seen as a task to be undertaken by a specialist (such as the Institute of Transport Studies) although the operator can easily apply the formula once the weights are determined by collecting new data from time-to-time without the need to re-estimate the weights (unless it was felt that preferences may have changed substantially over time).

135. Given the heterogeneity of the population of bus passengers, segment-specific service quality indicators can be identified.

136. Since completing this study a number of individuals have suggested additional attributes worthy of consideration in future updates. While not detracting from the value of the approach, these attributes are ticket type, time to find a seat (or amount of time standing), onboard temperature (degrees of hot and cold on board, as a more general attribute than air conditioning), on time at destination, extent of early running, time of day service coverage.

137. The number of attributes may appear to be large by most applications of SP methods in transportation. Indeed, one referee raised the question of "the limited capacity for the mind to hold more than about seven pieces of information simultaneously". While this assertion remains controversial, we recognise the possibility that an individual may review all attributes and ignore some of them. This does not mean, however, that the process is necessarily lexicographic but rather that specific attributes are simply not relevant. There could, however, be a fatigue effect at play although our investigations herein suggest that this is not the case since we only offer three choice sets to each passenger. Louviere (personal communication) advises that he often considers over 10 attributes and finds the respondents act consistently, albeit with smaller variance on the unobserved effects.

138. We deliberately allowed the operators a degree of flexibility in the data collection process (which was taken into account in the analysis to control for any differences that may bias the results). Operators adopted one of three methods – hand out and collect onboard (pencil provided and board to lean survey form on),

hand out onboard and return by reply post-paid letter, or hand out onboard and return to driver on next trip. The first two methods were implemented.

139. Schoolchildren were excluded from the sample, as they are captive users and might have a biased perception towards the attributes. A referee indicated that schoolchildren should be included in SQI studies; however the focus of the current study was to develop and test the potential of SQI as a measure of service quality rather than to secure data from all bus markets. Furthermore all operators are the only provider of public transport services in their area and do not compete directly with rail. Some operators have timetables however that are designed to complement the rail timetable so as to attract patronage whose main mode is rail in situations where bus is specialising in access to rail.

140. In a complementary paper (Hensher, 2000b) we have estimated a mixed logit model taking into account correlation across the three choice sets as well as permitting attributes to have random parameters. The results do not change the findings herein although a mixed logit specification with random parameters adds enormous complexity in the implementation of SQI, something, which the referees promoted as undesirable if SQI is to have operational merit.

141. This is a very good statistical fit for a non-linear model and is recognised in the discrete choice literature as equivalent to a linear R^2 of between 0.7 and 0.8.

142. The SQI for each operator is calculated by applying the parameter estimates in Table 13.3 together with the current trip attribute levels (not the SP attribute levels) to each sampled passenger for an operator, and taking the mean and standard deviation (as given in Table 13.4).

143. In terms of targets, travel time might be influenced by policies of controlling authorities (e.g., bus lane provision), likewise fare might be affected by area-wide policies. The proportion of off-bus ticketing would also affect journey times, since boarding time forms a substantial proportion of the total. Hence, the SP results could be used to prioritise policies by the controlling authority, as well as individual operators.

144. The ranking of these operators were 2, 6 and 14. Even operators with relatively low SQI's were supportive, which is encouraging given evidence that poor performing operators on financial indicators often reject such processes. Subsequently the Regulator was briefed and was very positive about the opportunities that SQI holds in a performance assessment regime. The State based bus company that did not participate has since asked to be involved in future research in refining SQI.

145. Best practice is defined by the overall SQI and not individual attributes.

146. This is only possible because of the linear additive assumption of the preference model.

147. 'Monitoring can be done directly by observation'. The problem with this approach is that we have no way of observing a passenger's new level of satisfaction with any revision in service quality. Who are we observing? However, it is true that we can complement the passenger's perceptions of any changes with measures such as external observation of the driver's performance, tracking on-time arrival etc. But the latter data is an addition and not an alternative to SQI.

148. Given the heterogeneity of the population of bus passengers, segment-specific service quality indicators can be identified.

149. These 13 attributes are not the same set as those evaluated in the pilot.

150. Although laptop-based SC experiments are generally preferred and indeed it is the standard method used by the authors in most studies, it was not possible to undertake the current on-board survey using laptops. Interviewers would have been required and the cost would have been well beyond the available budget of the bus operators. We have recently developed an internet-based survey instrument, which will enable operators to undertake service-quality surveys at little expense prior to analysis. The downside is the preservation of a representative sample.

151. Segments 1 and 2 are general and hypothetical terms here; this discussion does not refer to specific results of this experiment.

152. We investigated a number of attribute interactions but they did not add significantly to the overall goodness-of-fit. However we wanted to keep the formula linear in order to simplify the process of excluding specific attributes where the regulatory focus on service quality might be limited to a few attributes (see Hensher & Prioni, 2002).

153. The values in Table 15.7 are calculated by multiplying the RP attribute levels by the appropriate weight in Table 15.6, summing across the sample of passengers in the segment and taking an average, and then multiplying by the scale parameter.

154. A referee suggested that time and cost should not be included in the calculation of SQI, and if they should, then they should be normalized by distance. Although this is a very interesting insight and one that we have thought about a lot, we argue that all attributes are true contributors to service quality as promoted in this paper and the only way to properly place each attribute representing information on individual's preferences for alternative service levels is to include all statistically significant attributes. We would also argue that the utility or satisfaction associated with many of the attributes (notably all on-board attributes) varies with distance travelled and to exclude only time and cost on this reasoning is not valid. The focus is on passengers choosing a package of attribute levels as the basis of choosing one service over another. It is not focused on a preference for an individual attribute per se but on how the attributes are mixed (through packaging) in delivering an overall service level that is the basis of choosing a service. However a nice feature of the approach is that it is very easy to remove an attribute to re-benchmark.

155. The following files were prepared for the BCA (but not available with this chapter: the ITS BIC model in 2002 dollars; the ITS BIC model updated to 2003 dollars; the PwC BIC model updated to 2003 dollars; non-commercial contract KPIs by operator; and, commercial contract KPIs by operator.

156. Linked trips allocate a trip to a priority mode. The priority used by the NSW Transport Data Centre (TDC) is 1 = car driver, 2 = car passenger, 3 = train, 4 = bus, 5 = ferry, 6 = taxi, 7 = walking, 8 = bicycle and 9 = other. Thus a bus trip to a railway station is assigned to the linked trip with train as priority mode. This is unfortunate for private buses in particular since they are a major mode for accessing a railway, in contrast to the government operator in Sydney who services locations where bus is typically the priority mode. In recent years, the development of free car parking at railway stations has reduced the number of bus trips to the station that

have been replaced by car travel. Hence one must be careful in the interpretation of travel statistics. As this definition is applied across time, the trend is, however, still informative.

157. The base case is a scenario of 'business as usual'; the policy case is the change in service or fare level.

158. Changes in generalised cost of car travel can be delivered through pricing (e.g., congestion and parking charges) and non-pricing instruments (e.g., banning car access to part of the network).

159. The Transport Data Centre (2002) report summarising data from the *Sydney Household Travel Survey* (1997/2001) indicates that the number one reason for using public transport to work is that it 'avoids parking problems and costs' followed by the number 2 reason 'do not have a car'. Parking policy and taxation policy are likely to be better examples of public policy instruments than fares and frequency to secure modal switching.

160. One increasingly hears of niche markets growing patronage by a sizeable percentage, usually however from a very low base and hence it is no surprise that the patronage growth is impressive. When the niche success is translated back into the aggregate impact on the market modal share the numbers are very small indeed. However such niche successes should be encouraged but recognised for what they are. Most of the statistics from Europe and North America that glow with strong patronage growth are very much niche contrasts.

161. At a presentation of the theme of this paper at the Warringah Council Civic Centre on 22 May 2002, in closing the session the Mayor suggested that the sports facility at Brookvale could have a parking station under the oval which would serve as a park-n-ride interchange for a high-frequency bus service (almost a subscription service) to and from the two main locations outside the Warringah peninsula (namely North Sydney and the City). We promoted the idea jointly of a quality contract partnership between the Council (owners of the oval), the car-park developers and the government bus provider to deliver this door-to-door transport capability such that the risks and rewards are shared. Parkers using the bus service might be given heavily discounted secure parking that is cross subsidised by parkers who do not use the bus service. A portion of the revenue from parking might also be hypothecated to public transport improvements.

162. Niche does not mean serving a single market such as a shopper service to the local shops.

163. For example, commercial bus contracts in NSW are based on a rule that requires primary routes to be complemented by secondary routes (in peak hours and shopping hours) so that 95% of the net patronage potential reside within 400 m of a primary or secondary route. This 400 m requirement is not well understood. The contracts do not specify a bus stop within 400 m of every residence/resident. The key contractual requirements hinge on 95% of net patronage potential (NPP). NPP discounts total population according to car ownership and competing rail and bus services in the area. "A primary route is … where 95% of the NPP of the contracted region reside within 800 m of those routes".

164. It may have served the needs of politicians in being able to say that they are providing public transport for all – but at what cost to the taxpayer?

165. The State Transit Authority (STA) of NSW subscribes strongly to the 'corridor' concept in service planning. Corridors are stronger in some areas than others due to topography, historical development and road networks. For example, there is a strong corridor in the Warringah peninsula area due to pattern of development along Pittwater Rd. Corridors are not as strongly defined in the STA's south-west region (e.g., inner west area).

166. Strictly speaking the Australian official definition of an elderly person is someone over the age of 85. The age range 55–85 is referred to as 'seniors'. The advice from Bronwyn Bishop (MHR for Makeller) is appreciated.

167. They also have a strong preference for car use.

168. Hass-Klau had circulated a number of reports prior to the 2002 publication. The media in the UK widely quoted this material.

169. The Rapid Transit Monitor published by TAS in the UK identifies 30 projects for light rail and tramway schemes in the UK including extensions to existing systems that are struggling financially. The systems in Croydon, Manchester and the West Midlands did not make enough profits in the recent financial year to cover interest charges on their loans. The Docklands Light Railway and Sheffield's Supertram required on-going subsidy to cover operating losses. These are described in the report as worrying signs for the government.

170. 700 London Transport buses have been fitted with particulate traps in the last 12 months at a cost of approximately $Aus3.5 m (see www.londontransport.co.uk).

171. This is also true in Australian cities except that the loss of employment activity is being replaced by growing tourism activity and to some extent residential activity in high-rise apartments, especially in Sydney and Melbourne. Despite the amount of high-rise residential activity it appears to be complementary to walking and car use (with extensive basement car parking provided).

172. Hutchinson (2000) provides an interesting commentary of the role of rational debate.

173. The latest critic of busway systems in favour of light rail (Carmen Hass-Klau, lead author of 'Bus or light Rail: Making the Right Choice') states that the infrastructure costs are closer together than has often been assumed and quotes busways at 526,000 lbs/km and light rail (and guided busways) at $561,000−702,000 per kilometre. One would hardly suggest from this evidence that light rail is more favourable!

174. A noteworthy piece of Australian evidence is that the new parking lots at Sydney suburban stations are tending to attract individuals who already use the rail system, but who now drive and park rather than use the local bus service to and from the station.

175. The Liverpool–Parramatta Transitway is the first effort in Sydney to develop a bus-based corridor that is clearly emulating the imaging offered by a rail system, if this is really what it takes to deliver value for money. The issue of whether light rail or a bus-based transitway is best value for money is clear but whether the location of this specific transitway is indeed appropriate (especially given its demonstration role) has been questioned.

176. A Harvard University study completed in 1999 indicates that the health hazards from CNG compared to diesel are much greater for fine particulate matter. This is because the particular matter associated with CNG is finer than for diesel and consequently is less visible and moves further down the throat track.

177. The figures shown in the MAN tests have been confirmed by other European manufacturers using Euro 2 engines as part of the 'Oil Program of the European Union'.

178. No down time has been costed for the CNG vehicle for the conversion process, although industry sources indicate a net cost of about 3 weeks against CNG for this process (i.e., 4 weeks conversion time for CNG, less 1 week for diesel engine rebuild at some time). Similarly, no major replacement has been assumed during the analysis period.

179. This is the position supported by BIC on grounds of the environmental performance of a modern diesel engine using low-sulfur fuel.

180. BIC notes that if there is no decision to increase axle mass limits and the merits of narrowing the environmental disadvantage of diesel compared to gas for modern diesel vehicles using low sulfur fuel are accepted, the disadvantage of gas would exceed $100,000 on a whole-of-life basis.

181. A very important aspect of the new performance assessment regime (PAR) proposed in NSW for commercial bus contracts is the opportunity to move away from the very strict supply-side focus on spatial coverage and minimum frequency that is not consistent with what actual and potential users may really want as a best service (taking into account commercial and social obligations). A re-focus that emphasises the passenger (in particular) and the community in general means that the market can be the effective arbiter of whether a service is meeting the needs of the contract area. A value for money formula linked to SQI can provide the formal mechanism for establishing whether an operator is serving the community in terms of delivering appropriate levels of service quality that are consistent with a value for money indicator. This re-orientation provides greater incentives for operators to deliver appropriate services to the market than the somewhat rigid and incentive incompatible standards associated with the 1990 NSW Passenger Transport Act. This new direction is incentive compatible. Importantly, we must recognise that the market is very powerful and that customers will provide the richest information of the value of a service. The role of the regulator is to ensure that we take advantage of this market information. Value for money would be calculated under the PAR by relating the SQI and patronage levels to the costs of service delivery. Specifically, we can apply a very simple but powerful formula to measure Patronage Service Effectivenss per dollar outlaid

Value for money = 1/{Total cost of service provision/(♯passenger trips*SQI per passenger)}.

The greater this inverse ratio the greater the value for money. We could also modify the formula to define it as Patronage Service Effectiveness per dollar of government support outlaid:

Value for money = 1/{Non-farebox and non-other concessional reimbursement cost of service provision/(♯passenger trips*SQI per passenger)}.

182. Economists have advocated congestion pricing for decades and technology has developed to a stage where it is a viable option. The problem is not that it would not work, only a few jurisdictions such as Singapore and Hong Kong have felt the case is sufficiently compelling to take the political risk of introducing it. Traffic congestion itself is a rationing device and one of the known problems is that there is such a latent demand for travel in peak periods that any measure to shift some of the traffic has to cope with the generation of new trips. Despite this, economists consider that road pricing is likely to have a significant impact where traffic congestion is severe. The payoff is a more efficient transport system, but in addition there is evidence it would result in less energy consumption and reduced emissions. Economists argue that efficient road pricing would result in the highest prices on inner urban roads. This is precisely where land is scarcest and where it is relatively costly to allow for car use. The effect would be to encourage more employment in outer areas and a reduction in car travel.

183. The TRESIS is an example of such a decision support tool (Hensher & Tu, 2000).

REFERENCES

ACCC. (2000). Report on the movement in fuel prices in the September Quarter 2000. Canberra: Australian Consumer and Competition Commission, October.

Acutt, M. Z., & Dodgson, J. S. (1996). Cross-elasticities of demand for travel. *Transport Policy*, *2*(4), 271–277.

Alexander, E. R. (2000). Why planning vs. markets is an oxymoron: Asking the right question. *Planning and Markets*, *4*(1), 1–8.

Alexandersson, G., & Hulten, S. (2003). The problem of predatory pricing in competitive tenders – A Swedish case study. Paper prepared for the 8th international conference on competition and ownership in land passenger transport, Rio de Janeiro, Brazil, 14–18 September.

Allenby, G., & Ginter, J. (1995). The effects of in-store displays and feature advertising on consideration sets. *International Journal of Research in Marketing*, *12*, 67–80.

Almanaque Abril. (1993). *Bus rapid transit*. Sao Paulo: Grupo Abril.

Alsnih, R., & Hensher, D. A. (2003). The mobility and accessibility expectations of seniors in an aging population. *Transportation Research A*, *37*(10), 903–916.

Anonymous. (1993). *An investigation into the effectiveness of public transport initiatives, prepared for Surrey County Council*. Surrey.

ATP. (1994). *Technical address to visiting Australian bus operators – June 1994*. Porto Allegre: Transport Companies of Passengers Association of Porto Allegre (unpublished).

Baggaley, J., & Fong Choon Khin, M. (1994). Farecards: The fair way forward? *Proceedings of the international conference on advanced technologies in transportation and traffic management*. Singapore Land Transport, Singapore, 18–20 May.

Barten, A. P. (1977). The systems of consumer demand functions approach: A review. *Econometrica*, *45*, 23–51.

Batz, T. M. (1986). *High occupancy vehicle treatments, impacts, and parameters, Volumes I and II*. Report prepared for the Office of the Secretary of Transportation. U.S. Department of Transport, Washington, DC.

Beesley, M. E., Gist, P., & Glaister, S. (1983). Cost benefit analysis and London's transport policies. *Progress in Planning*, *19*(3).

Ben-Akiva, M. E., & Lerman, S. (1985). *Discrete choice analysis: Theory and application to travel demand*. Cambridge: MIT Press.

Ben-Akiva, M. E., & Morikawa, T. (1991). Estimation of switching models from revealed preferences and stated intentions. *Transportation Research*, *24A*(6), 485–495.

Berechman, J. (1993). Public transit economics and deregulation policy. In: P. Nijkamp (Ed.), *Studies in regional science and urban economics* (Vol. 23). Amsterdam: North-Holland.

Berge, D. M., Brathen, S., Hauge, O., & Ohr, F. (2003). *Experiences with quality contracts in public transport in Norway*. Norway: Molde University College and Molde Research Institute.

Bhat, C. R. (1995). A heteroscedastic extreme value model of intercity travel mode choice. *Transportation Research*, *29B*(6), 471–483.

Bhat, C. R. (1996). *Accommodating variations in responsiveness to level-of-service measures in travel mode choice modeling*. Department of Civil Engineering, University of Massachusetts at Amherst.

Biehler, A. D. (1989). Exclusive busway versus light rail transit, Light Rail Transit: New system successes at affordable prices. Special Report 221, Transportation Research Board, Washington, DC, pp. 89–97.

Blundell, R. (1988). Consumer behaviour theory and empirical evidence – a survey. *Economic Journal*, *98*, 16–65.

Bovy, P., Orfeuil, J. P., & Zumkeller, D. (1993). Europe: A heterogeneous 'single market'. In: I. Salomon, P. Bovy & J. P. Orfeuil (Eds), *A billion trips a day: Tradition and transition in European travel patterns* (pp. 21–32). Dordrecht: Kluwer Academic Publishers.

Bradley, M. A., & Daly, A. J. (1997). Estimation of logit choice models using mixed stated-preference and revealed-preference information. In: P. R. Stopher & M. Lee-Gosselin (Eds), *Understanding travel behaviour in an era of change* (pp. 209–232). Oxford: Pergamon.

Bray, A. (2002). Competitive performance. *Australasian Bus and Coach*, *14*(10), 22–29.

Brearley, R. A., Myers, S. C., Partington, G., & Robinson, D. (2000). Risk, return, diversification and the opportunity cost of capital. *Principles of corporate finance*. Sydney: McGraw-Hill.

Breiman, L., Friedman, J., Olshen, R., & Stone, C. (1993). *Classification and regression trees*. New York: Chapman & Hall.

Brindle, R. E. (1992). Land use and transport in Toronto. Working Document No WD RS92/017, Australian Road Research Board, Melbourne.

Brog, W., & Erl, E. (1996). Can daily mobility be reduced or transferred to other modes? European Conference of Ministers of Transport (ECMT), Round Table 102, ECMT, Paris.

Brown, A., & Deaton, A. (1972). Surveys in applied economics: Models of consumer behaviour. *Economic Journal*, *82*, 1145–1236.

Bullock, P., Stopher, P., Pointer, G., & Jiang, Q. (2003). GPS measurement of travel times, driving cycles, and congestion. Paper presented to SatNav 2003 – 6th international symposium on satellite navigation, Melbourne, Vic., July.

Burnbank Consulting and Tasman Asia Pacific. (1999). *Submission to the motor vehicle environment committee's review of Australia's vehicle emissions standards.* Report prepared for the Bus Industry Confederation, January (distributed to students in class material).

Bus Industry Confederation. (2001). *Getting the prices right: Policy for more sustainable fuel taxation for road transport in Australia*. Submission to the Commonwealth Fuel Tax Inquiry, October.

Bus Industry Council (BIC). (1999). *Comparison of diesel and gas for urban buses.* Report submitted to the Federal Government, August.

Carlquist, E. (2001). Incentive contracts in Norwegian local public transport: The Hordaland model. Paper presented at the 7th international conference on competition and ownership of land passenger transport, Molde, Norway, June.

Carlquist, E., & Frøysadal, F. (2001). *Kontraktsformer i norsk busstransport.* TØI særtrykk 220/2001. Institute of Transport Economics, Oslo.

Carlquist, E. (2002). Comments on this paper. Personal email communication, 18 July.

Carter, D., & Pollan, C. (1994). *A joint effort: Multi-operator fare integration.* California: Booz Allen and Hamilton.

Caves, D. W., Christensen, L. R., & Diewert, W. E. (1982). Multilateral comparisons of output, input, and productivity using superlative index numbers. *The Economic Journal*, *92*(March), 73–86.

Chapman, P. (1992). The Adelaide O-Bahn: How good in practice, *Papers of the Australasian Transport Research Forum*, *17*(Part 1), 83–100.

Charles River Associates. (1989). *Development of a consensus paper on how transit transfers affect ridership*. Memorandum CRA No. 527.00, September.

Citizen's League. (1991). Statement on the Regional Transit Board of Minnesota, Light rail transit: The Regional Transit Board's proposal to the 1991 Minnesota Legislature, Minneapolis, January.

Clark, P. M. E. (1999). Using stated preference techniques to investigate travel choices – some applications with particular reference to South Africa. Seminar on appropriate data for South Africa. Department of Civil Engineering, University of Pretoria, Pretoria, South Africa.

Cmabini, C., & Filippini, M. (2003). Competitive tendering and optimal size in the regional bus transportation industry. An example from Italy. *Annals of Public and Cooperative Economics*, *74*(1), 163–182.

CMTC. (1994). Discussions with delegation of Australian bus operators, Washington Luiz Elias Correa, Diretor de Desenvolvimento e Technologia. Companhia Municipal de Transportes Coletivos, Sao Paulo, 29 June.

Cornwell, P., & Cracknell, J. (1990). The case for busway transit. PTRC 18th summer annual meeting. (This paper is a summary of TRL Research Report 329 and Overseas Road Note 12 of the Transport Research Laboratory, Berkshire, UK.)

Cosgrove, D., & Gargett, D. (1992). The Australian domestic transport task. *Paoers of the Australasian Transport research Forum*, *17*(1), 231–249.

Cox, W. (1991). *Monitoring of the financing and utilisation of light and heavy rail systems in the U.S.A.* Internal Memorandum, Wendell Cox Consultancy, IL, USA, 20 July.

Cunningham, L. F., Young, C., & Lee, M. (1997). Developing customer-based measures of overall transportation service quality in Colorado: Quantitative and qualitative approaches. *Journal of Public Transportation*, *1*(4), 1–22.

Daniels, R. (2002). Comments on cost differences. Personal communication, 31 May.

de Weger, T. H. D., & de Jong, L. (2001). Public transport infrastructure for bus systems in the Netherlands. Paper presented at the 7th international conference on competition and ownership of land passenger transport, Molde, Norway, June.

Deaton, A., & Muellbauer, J. (1980). *Economics and consumer behaviour*, Cambridge: Cambridge University Press.

DeBorger, B., & Kerstens, K. (2000). The performance of bus-transit operators. In: D. A. Hensher & K. J. Button (Eds), *Handbook of transport modelling*, Handbooks in Transport (Vol. 1, pp. 577–595). Oxford: Pergamon Press.

DeBorger, B., Mayers, I., Proost, S., & Wouters, S. (1996). Optimal pricing of urban passenger transport, a simulation exercise for Belgium. *Journal of Transport Economics and Policy*, *30*(1), 31–52.

Denis Johnstone & Associates. (1992). *Canberra transport study: Study of future public transport options, report on Stage 1*. Report prepared for the ACT Administration, Canberra, September.

Department of Transport & Regions (DTLR). (2002). *Transport statistics bulletin survey of concessionary bus fare schemes in England 2001*. London: DTLR.

Dinning, M. (1996). *The business case for smartcards in public transit systems*. US Department of Transportation, Washington, DC.

Domberger, S., Hall, C., & Ah Lik Li, E. (1995). The determinants of price and quality in competitively tendered contracts. *The Economic Journal*, *105*, 1454–1470.

Drucker, P. (1992). The new society of organizations. *Harvard Business Review* (September—October), 95–104.

Edwards, M., & Mackett, R. L. (1996). Developing new urban public transport systems: An irrational decision-making process. *Transport Policy*, *3*, 225–239.

EIU. (1991). Brazil country profile. The Economist Intelligence Unit, London.

EMTU. (1993). *Comeca Acqui Uma Boa Viagem*. Empresa Metropolitana de Transportes Urbanos de Sao Paulo S.A. publicity video, Sao Paulo.

Environmental & Transport Planning. (2000). *Bus or light rail: Making the right choice*. London: Landor Publishing Ltd.

Fairhurst, M. H. (1993). *Fares and ticketing policy in London: From travelcards to smartcards*. Research Report R273, LT Planning Department London Transport, July.

Fielding, G. J., Babitsky, T. J., & Brenner, M. E. (1985). Performance evaluation for bus transit. In: D. A. Hensher (Ed.), *Competition and ownership of public transit*. (A special issue of *Transportation Research*, *19*(1), 73–82.)

Flyvbjerg, B., Bruzelius, N., & Rothengatter, W. (2003). *Megaprojects and risk: An anatomy of ambition*. Cambridge: Cambridge University Press.

Foote, P., & Darwin, S. (2001). Impacts of transit fare policy initiatives under an automated fare system. *Transportation Quarterly*, *54*(3), 51–66.

Fouracre, P. R., & Gardner, G. (1992). Mass transit in developing cities: The role of high performance bus systems. *Proceedings of the institution of mechanical engineers international conference bus '92: The expanding role of buses towards the twenty-first century* (pp. 231–237).

FuelTrac. (2003). New South Wales FuelTrac pricing summary unleaded petrol (cents per litre), price monitoring, [online] available: http://www.aaa.asn.au/petrol.htm link: latest petrol prices-NSW and ACT [March 5].

Gardner, G., & Fouracre, P. (1990). Busway transit – the TRRL study. PTRC 18th annual summer meeting.

Gaudry, M., Jara-Diaz, S. R., & Ortuzar, J. de D. (1988). Value of time sensitivity to model specification. *Transportation Research*, *23B*, 151–158.

Giuliano, G., Levine, D. W., & Teal, R. F. (1990). Impact of high occupancy vehicle lanes on carpooling behaviour. *Transportation*, *17*(2), 159–178.

Glaister, S., & Cox, W. (1991). The bidding process (for the supply of bus services). *Transportation Planning and Technology*, *15*(2/4), 145–152.

Glaister, S., & Lewis, D. (1978). An integrated fares policy for transport in London. *Journal of Public Economics*, *9*, 341–355.

Golicic, S. L., Foggin, J. H., & Mentzer, J. T. (2003). Relationship magnitude and its role in interorganizational relationship structure. *Journal of Business Logistics*, *24*(1), 57–75.

Goodwin, P. B. (1992). A review of new demand elasticities with special reference to short and long run effects of price changes. *Journal of Transport Economics and Policy*, *XXVI*(2), 155–169.

Goodwin, P. B., Hallett, S., Kenny, F., & Stokes, G. (1991). *Transport: The new realism*. Report to Rees Jeffrey Road Fund, Transport Studies Unit, University of Oxford.

Gordon, P., & Muretta, P. (1983). The benefits and costs of the San Bernardino busway: Implications for planning. *Transportation Research*, *17a*(2), 89–94.

Gordon, P., & Wilson, R. (1985). The determinants of fixed-rail transit demand: An international cross-sectional comparison. In: K. J. Button & D. E. Pitfield (Eds), *International railway economics*. Hants: Gower Publishing.

Green, H. A. J. (1976). *Consumer theory* (Revised edition). London: Macmillan.

Greene, W. (1996). *Heteroskedastic extreme value model for discrete choice*. New York University.

Grossman, S., & Hart, O. (1986). The costs and benefits of ownership: A theory of vertical and lateral integration. *Journal of Political Economy*, *94*(4), 691–719.

Hart, O. (1989). An economist's perspective on the theory of the firm. *Colombia Law Review*, *89*(7).

Hart, O., & Holmstrom, B. (1987). The theory of contracts. In: T. Bewley (Ed.), *Advances in economic theory*. Cambridge: Cambridge University Press.

Hart, O., & Moore, J. (1990). Property rights and the nature of the firm. *Journal of Political Economy*, *98*(6), 1119–1158.

Hass-Klau, C., & Crampton, G. (2002). *Future of urban transport: Learning from success and weaknesses: Light rail, environment and transport planning*. Brighton, UK: Transport Environment Planners.

Hay, D., & Vickers, J. (1987). *The economics of market dominance*. Oxford: Basil Blackwell.

Henry, L. (1989). *Ridership forecasting considerations in comparisons of light rail and motor bus modes, light rail transit: New system successes at affordable prices*. Special Report 221, Transportation Research Board, Washington, DC, pp. 163–189.

Hensher, D. A. (1984). Achieving representativeness of the observable component of the indirect utility function in logit choice models: An empirical revelation. *Journal of Business*, *57*(2), 265–280.

Hensher, D. A. (1989). *The structure and performance of the private bus and coach industry in Australia.* Final report under the Volvo Research Grant, prepared for the Australian Bus and Coach Association, August.

Hensher, D. A. (1991). Hierarchical stated response designs and estimation in the context of bus use preferences. *Logistics and Transportation Reviews*, *26*(4), 299–323.

Hensher, D. A. (1992a). *Bus priority systems in metropolitan areas: A strategic assessment and framework document*. Report prepared for the NSW Department of Transport, Sydney, October.

Hensher, D. A. (1992b). Total factor productivity growth and endogenous demand: Establishing a benchmark index for the selection of operational performance measures in public bus firms. *Transportation Research*, *26B*(5), 435–448 (special issue on performance measurement, guest edited by D.A. Hensher).

Hensher, D. A. (1993a). *Greenhouse gas emissions and the demand for urban passenger transport: Design on the overall approach.* Report 1, Institute of Transport Studies, The University of Sydney, October (also published in 1994 as BTCE Occasional paper 108, Department of Transport and Communications, Canberra).

Hensher, D. A. (1993b). Socially and environmentally appropriate urban futures for the motor car. *Transportation*, *20*(1), 1–20.

Hensher, D. A. (1993c). Performance evaluation and passenger transit: What are the relevant measures? Proceedings of *The Second International Conference on Privatisation and Deregulation of Passenger Transport*, to appear.

Hensher, D. A. (1994). Stated preference analysis of travel choices: The state of practice. *Transportation*, *21*(2), 107–134.

Hensher, D. A. (1997a). A practical approach to identifying the market for high speed rail: A case study in the Sydney–Canberra corridor. *Transportation Research A*, *31A*(6), 431–446.

Hensher, D. A. (1997b). Value of travel time savings in personal and commercial automobile travel. In: D. Greene, D. Jones & M. Delucchi (Eds), *Measuring the full costs and benefits of transportation*. Berlin: Springer.

Hensher, D. A. (1998a). 'The balance between car and public transport use in urban areas: What can we do about it?' Presented at the 1998 national conference of the Australian Bus and Coach Association, Cairns, April. *Transport Policy*, *5*(4), 193–204.

Hensher, D. A. (1998b). Establishing a fare elasticity regime for urban passenger transport. *Journal of Transport Economics and Policy*, *32*(2), 221–246.

Hensher, D. A. (1999). Bus-based transitway or light rail? Continuing the saga on choice versus blind commitment. *Roads and Transport Research*, *8*(3), 3–21.

Hensher, D. A. (2000a). Extending valuation to controlled value functions and non-uniform scaling with generalised unobserved variances. In: T. Garling, T. Laitila & K. Westin (Eds), *Theoretical foundations of travel choice models*. Oxford: Pergamon.

Hensher, D. A. (2000b). *Service quality as a package: What does it mean to heterogeneous consumers?* Institute of Transport Studies, The University of Sydney, Sydney, July.

Hensher, D. A. (2002). A systematic assessment of the environmental impacts of transport policy: An end use perspective. *Environmental Resource Economics*, *22*(1–2), 185–217.

Hensher, D. A. (2003a). Contract areas and service quality issues in public transit provision: Some thoughts on the European and Australian context. *Journal of Public Transportation*, *6*(3), 15–42.

Hensher, D. A. (2003b). Urban public transport delivery in Australia: Issues and challenges in retaining and growing patronage. *Roads and Transport Research*, *12*(2), 31–41.

Hensher, D. (2003c). Influences on distance-based unit costs for non-urban bus operations in New South Wales. *Road and Transport Research*, *12*(1), 16–27.

Hensher, D. A. (2005). Performance evaluation frameworks. In: D. A. Hensher & K. Button (Eds), *Transport strategy, policy and institutions, handbooks in transport* (Vol. 6, pp. 83–96). Oxford: Elsevier, Chapter 6.

Hensher, D. A., & Bradley, M. (1993). Using stated response data to enrich revealed preference discrete choice models. *Marketing Letters*, *4*(2), 139–152.

Hensher, D. A., & Brewer, A. M. (2001). *Transport: An economics and management perspective*. Oxford: University of Oxford Press.

Hensher, D. A., & Bullock, R. G. (1979). Price elasticity of commuter mode choice. *Transportation Research*, *13A*(3), 193–202.

Hensher, D. A., & Daniels, R. (1995). Productivity measurement in the urban bus sector. *Transport Policy*, *2*(3), 179–194.

Hensher, D. A., & Greene, W. G. (2001). Choosing between conventional, electric and LPG/CNG vehicles in single-vehicle households. In: D. A. Hensher (Ed.), *The leading edge of travel behavior research* (pp. 725–750). Oxford: Pergamon Press.

Hensher, D. A., & Houghton, E. (2004). Performance-based quality contracts for the bus sector: Delivering social and commercial value for money. *Transportation Research B*, *38*(2), 123–146.

Hensher, D. A., & Houghton, E. (2005). Negotiated and competitively tendered performance based contracts. In: D. A. Hensher, & K. Button (Series and volume editors), *Transport* *strategy, policy and institutions, handbook in transport* (Vol. 6, Chapter 31, pp. 527–546). Oxford: Elsevier.

Hensher, D. A., & Houghton, E. (2005a). Performance-based contracts. Workshop report, 8th international conference on competition and ownership of land passenger transport, Rio de Janeiro, Brazil, September. In: D. A. Hensher (Ed.), *Competition and ownership of land passenger transport* (pp. 23–46). Oxford: Elsevier, Chapter 3.

Hensher, D. A., & Houghton, E. (2005b). Negotiated and competitively tendered performance based contracts. In: D. A. Hensher & K. Button (Eds), *Transport strategy, policy and institutions, handbooks in transport* (Vol. 6, pp. 527–546). Oxford: Elsevier, Chapter 31.

Hensher, D. A., & Houghton, E. (2005c). Implementing performance-based quality contracts in the bus sector. Growing patronage and transitional arrangements (Paper presented at the 8th international conference on competition and ownership of land passenger transport, Rio de Janeiro, Brasil, September). In: D. A. Hensher (Ed.), *Competition and ownership of land passenger transport* (Chapter 10, pp. 129–154). Oxfort: Elsevier.

Hensher, D. A., & Johnson, L. W. (1981). *Applied discrete-choice modelling*. London: Croom Helm.

Hensher, D. A., & King, J. (2001). Parking demand and responsiveness to availability, pricing and location in the Sydney central business district. *Transportation Research A*, *35A*(3), 177–196.

Hensher, D. A., Louviere, J. J., & Swait, J. (1999). Combining sources of preference data. *Journal of Econometrics*, *89*, 197–221.

Hensher, D. A., & Macario, R. (2002). Organisation and ownership of public transport services. *Transport Reviews*, *22*(3), 350–357.

Hensher, D. A., & Prioni, P. (2002). A service quality index for area-wide contract performance assessment regime. *Journal of Transport Economics and Policy*, *36*(1), 93–114.

Hensher, D. A., & Raimond, T. (1993). *FactSheet '93: The private bus and coach industry in Australia.* Prepared for the Australian Bus and Coach Association, Sydney.

Hensher, D. A., & Raimond, T. (1995). *Evaluation of fare elasticities for the sydney region.* Report prepared by the Institute of Transport Studies for the NSW Government Pricing Tribunal, Sydney, March.

Hensher, D. A., & Raimond, T. (1996). *Estimation of public transport fare elasticities in the Sydney region*. Research paper no. 7, Independent Pricing and Regulatory Tribunal of New South Wales, Sydney, October.

Hensher, D. A., & Stanley, J. K. (2003). Performance-based contracts and/or competitive tendering in urban bus service provision? *Transportation Research A*, *37*, 519–538.

Hensher, D. A., Smith, N. C., Milthorpe, F. W., & Barnard, P. O. (1992). *Dimensions of automobile demand: A longitudinal analysis*. North-Holland: Amsterdam.

Hensher, D. A., Stopher, P. R., & Bullock, P. (2003). Benchmarking and service quality at a market segment level (presented at the 2002 Annual Transportation Research Board Conference, Washington, DC). *Transportation Research A*, *37*, 499–517.

Hensher, D. A., & Ton, T. (2002). TRESIS: A transportation, land use and environmental strategy impact simulator for urban areas. *Transportation*, *29*, 439–457.

Hensher, D.A., & Wallis, I. (2005). Competitive tendering as a contracting mechanism for subsidising transportation: The bus experience. Invited paper for special issue of *Journal of Transport Economics and Policy*, *39*(3), 295–321.

Hensher, D. A., & Waters, W. G., II (1994). Light rail and bus priority systems: Choice or blind commitment? In: B. Starr Macmullen (Ed.), *Research in transportation economics*, (Vol. III, pp. 139–162). CT: JAI Press, Greenwich.

Herbst, K. (1992). Brazil's model city: Is Curitiba too good to be true? *Planning*, *58*(9), 24–27.

Hibbs, J. (2000). *Transport policy: The myth of integrated planning.* Hobart paper 140, Institute of Economic affairs, London.

Horowitz, A. J., & Zlosel, D. J. (1981). Transfer penalties: Another look at transfer riders' reluctance to transfer. *Transportation*, *10*, 279–282.

Horowitz, J. L. (1981). Identification and diagnosis of specification errors in the multinomial logit model. *Transportation Research*, *15B*(5), 345–360.

Hunt, J. D., & Abraham, J. (2003). Design and application of the PECAS land use modeling system. Paper presented at 8th international conference on computers in urban planning and urban management, Sendai, Japan.

Hutchinson, T. P. (2000). Discussion: A syllabus for transport studies. *Road and Transport Research*, *9*(2), 62–68.

IBGE. (1990). Anvario Estatistico do Brasil, Ministerio da Economia Fazenda e Plane Jamento Fundacao Instituto Brasileiro de Geografia e Estatistica -IBGE.

Institute of Transport Economics (ITE). (2000). Development of performance contracts in Norway. *Nordic Road and Transport Research*, *2*.

Institute of Transport Studies. (2002). *ITS warringah options study: Trip demand forecasts*. Report to the Bureau of Transport and Regional Economics, December.

Ip, K. (1992). *Cost-benefit analysis for four public transport systems*. Institute of Transport Studies, Graduate School of Business, The University of Sydney, Mimeo, Sydney.

IPART. (2002). *Report on fares for taxis, private buses and private ferries*. Independent Pricing and Regulatory Tribunal, Sydney, June.

James, B. (1998). Changing travel behaviour through individualised marketing: Applications and lessons from South Perth. *Proceedings, 22nd Australasian Transport Research Forum*, *22*(Part 2), 635–647.

Jansen, G. R. M. (1993). Commuting: Home sprawl, job sprawl, traffic jams. In: I. Salomon, P. Bovy & J. P. Orfeuil (Eds), *A billion trips a aay: Tradition and transition in European travel patterns* (pp. 101–128). Dordrecht: Kluwer Academic Publishers.

Jansson, J. O. (1984). *Transport system optimization and pricing*. New York: Wiley.

Jansson, J. O. (2001). Efficient modal split. Paper presented at the 7th international conference on competition and ownership of land passenger transport, Molde, Norway, June.

Jara-Diaz, S. (1996). Time and income in travel demand: Towards a microeconomic activity framework. Invited paper presented at the international conference on the theoretical foundations of travel choice models, Stockholm, August 7–11.

Jara-Diaz, S., & Ortuzar, J. deD. (1988). Introducing the expenditure rate in mode choice models. *Journal of Transport Economics and Policy*, *XXIII*(3), 293–308.

Jara-Diaz, S., & Videla, J. (1989). Detection of income effect in mode choice: Theory and application. *Transportation Research*, *23B*(6), 393–400.

Johansen, K. W., Larsen, O., & Norheim, B. (2001). Towards economic efficiency in public transport. *Journal of Transport Economics and Policy*, *35*(3), 491–511.

Kain, J. F. (1988). Choosing the wrong technology: Or how to spend billions and reduce transit use. *Journal of Advanced Transportation*, *21*, 197–213.

Kain, J. F. (1990). Deception in Dallas: Strategic misrepresentation in rail transit promotion and evaluation. *Journal of the American Planning Association*, *56*, 184–196.

Kain, J. F., & Liu, Z. (1995). Secrets of success: How Houston and San Diego transit providers achieved large increases in transit ridership. Report prepared for the Federal Tranit Administration, Washington, DC, May.

King, J. (1996a). *BCA(NSW) survey: Daily diary for non commercial contracts*. Institute of Transport Studies, Sydney, January.

King, J. (1996b). *BCA(NSW) survey: Survey of major operating costs for non commercial contracts: Analysis by zone of operation.* Institute of Transport Studies, Sydney, January.

King, J., & Hensher, D. A. (1999). How are urban bus fleets performing in reducing greenhouse gas emissions? The Australian experience. *Roads and Transport Research*, *8*(1), 3–11.

Klarmann, J. (2003). *Tendering problems of suburban rail systems*. Consultant, Italy.

Kraft, G., & Domencich, T. A. (1972). Free transit. In: M. Edel & J. Rothenburg (Eds), *Readings in urban economics*. New York: Collier-MacMillan.

Laffont, J. J., & Tirole, J. (1993). *A theory of incentives in procurement and regulation*. Cambridge: MIT Press.

Larsen, O. I. (2001). Designing incentive schemes for public transport operators in Hordaland County, Norway. Paper presented in Workshop D, international conference on competition and ownership of land passenger transport, Molde, Norway, June (Thredbo 7).

Laube, F. (1995). Fully integrated transport networks: An international perspective on applied solutions. Paper presented at Ticketing Technologies Conference, Darling Harbour, April 5–6.

Lave, C. A. (1992). Cars and demographics. *Access*, *1*(Fall), 4–11.

Lewis, D. (1977). Estimating the influence of public pricing policy on road traffic levels in Greater London. *Journal of Transport Economics and Policy*, *11*, 155–168.

Lieberman, W., Schumacher, D., Hoffman, A., & Wornum, C. (2001). Creating a new century of transit opportunity: Strategic planning for transit. *Transportation Research Record*, *1747*, 60–67.

Louviere, J. J. (1994). Conjoint analysis. In: R. Bagozzi (Ed.), *Advanced methods of marketing research* (pp. 223–259). Cambridge, MA: Blackwell Publishers.

Louviere, J. J., Fox, M., & Moore, W. (1993). Cross-task validity comparisons of stated preference choice models. *Marketing Letters*, *4*(3), 205–213.

Louviere, J. J., & Hensher, D. A. (1996). *Stated choice methods and analysis: A short course*. Portland: Portland State University June.

Louviere, J. J., Hensher, D. A., & Swait, J. (2000). Stated choice methods: Analysis and applications in marketing, transportation and environmental valuation. Cambridge: Cambridge University Press, p. 697.

Luk, J., & Hepburn, S. (1993). *New review of Australian travel demand elasticities*. ARRB report ARR249, Australian Road Research Board, Nunawading.

Luk, J. Y. K., Hepburn, S., & Thoresen, T. (1994). Real cost of car travel and congestion pricing. *Proceedings of the 17th ARRB Conference*, *17*(6), 207–218.

Luk, J. Y. K., Rosalion, N., Brindle, R., & Chapman, R. (1998). *Reducing road demand by land-use changes, public transport improvements and TDM measures – a review*. Research report ARR313, ARRB Transport Research, Melbourne.

Macário, R. (2001). Managing and assessing regulatory evaluation in local public transport operations in Europe. Paper presented at the 7th international conference on competition and ownership of land passenger transport, Molde, Norway, June.

Macário, R., & Viegas, J. (1999). Regulating the performance of urban public transport systems in differenet regulatory settings. Paper presented at the international conference on competition and ownership of land passenger transport, Cape Town, South Africa (Thredbo 6).

Mackett, R. L., & Edwards, M. (1996a). Guidelines for planning a new urban public transport system. *Proceedings of the Institution of Civil Engineers: Transport*, *117*, 193–201.

Mackett, R. L., & Edwards, M. (1996b). An expert system to advise on urban public transport technologies. *Computers, Environment and Urban Systems*, *20*, 261–273.

Mackett, R. L., & Edwards, M. (1998). The impact of new urban public transport systems: Will the expectations be met. *Transportation Research*, *32A*(4), 231–245.

Madan, D. B., & Groenhout, R. (1987). Modelling travel mode choices for the Sydney work trip. *Journal of Transport Economics and Policy*, *21*(2), 135–139.

Mannering, F., & Winston, C. (1985). Dynamic empirical analysis of household vehicle ownership and utilization. *Rand Journal of Economics*, *16*(2), 215–236.

Mayworm, P., Lago, A. M., & McEnroe, J. M. (1980). Patronage impacts of changes in transit fares and services. Ecosometrics Incorporated, Bethesda, MD.

McCarthy, M. (1995). *Greenhouse gas emissions and the demand for urban passenger transport: Graphical presentation of community views on greenhouse gas emissions and other environmental topics*. Report 6, Institute of Transport Studies, The University of Sydney, Sydney, February.

McCarthy, M., & Hensher, D. A. (1995). *Greenhouse gas emissions and the demand for urban passenger transport: Descriptive profile of travel survey data.* Supplementary report 6A, Institute of Transport Studies, The University of Sydney, Sydney, May.

McFadden, D. (1974). The measurement of urban travel demand. *Journal of Public Economics*, *3*, 303–328.

McFadden, D. (1979). Quantitative methods for analysing travel behaviour of individuals: Some recent developments. In: D. A. Hensher & P. R. Stopher (Eds), *Behavioural travel modelling*. London: Croom Helm.

McFadden, D. (1981). Econometric models of probabilistic choice. In: C. F. Manski & D. McFadden (Eds), *Structural analysis of discrete data with econometric applications* (pp. 198–272). Cambridge: MIT Press.

McFadden, D. (1984). Econometric analysis of qualitative response models. In: Z. Griliches & M. D. Intriligator (Eds), *Handbook of econometrics*, Vol. II. Amsterdam: North-Holland Chapter 24.

Mees, M. (1998). Light rail in Sydney: Who uses it, and does it reduce car use? Paper presented at the 20th conference of Australian institutes of transport research, Institute of Transport Studies, University of Sydney, Sydney, December 14–15.

Mills, G., & Gale, J. (2002). Funding of public transport and infrastructure: Theme D. Workshop report 7th international conference on competition and ownership of land passenger transport, Transport Reviews.

Moffat, K. A. (1991). Buses for the '90's. PTRC 19th summer annual meeting, University of Sussex, England, pp. 55–64.

Morikawa, T. (1989) *Incorporating stated preference data in travel demand analysis.* Ph.D. dissertation, Department of Civil Engineering, MIT.

Muren, A. (2000). Quality assurance in competitive tendered contracts. *Journal of Transport Economics and Policy*, *34*(1), 99–112.

Murphy, J. J., & Delucchi, M. A. (1998). A review of the literature on the social cost of motor vehicle use in the United States. *Journal of Transportation and Statistics*, *1*(1), 15–42.

Nash, C. A., & Jansson, K. (2002). Competition and regulation in public transport: Theme B. Workshop report 7th international conference on competition and ownership of land passenger transport. *Transport Reviews*, *22*(3), 346–349.

Newman, P. W., & Kenworthy, J. R. (1989). *Cities and automobile dependence: An international sourcebook*. UK: Gower.

Nisar, M., Khan, A. M., & Johnson, W. F. (1989). Transitways offer superior level of service and economic efficiency. *World Conference of Transport Research Proceedings*, Yokohama (Vol. III, pp. 247–261).

Norheim, B., & Longva, F. (2005). Quality tendering and contracting service design – comparing the Dutch and Norwegian initiatives. Paper presented at the 9th international conference on competition and ownership of land passenger transport, Lisbon, Portugal, September.

Oppenheim, N. (1995). *Urban travel demand modelling*. New York: Wiley.

Ortuzar, J. de D., & Willumsen, L. G. (1994). *Modelling transport* (2nd ed.). New York: Wiley.

Oum, T. H., Tretheway, M. W., & Waters, W. G., II (1992a). Concepts, methods and purposes of productivity measurement in transportation. *Transportation Research*, *26A*(6), 493–505.

Oum, T., Waters, W. G., & Yong, J. (1992b). Concepts of price elasticities of transport demand and recent empirical evidence. *Journal of Transport Economics and Policy*, *26*, 139–154.

Paaswell, R. E., & Berechman, J. (1982). *Light rail and development: Constraints and conditions, light rail transit: Planning, design, and implementation*. Transportation Research Board Special Report 195, Transportation Research Board, Washington, DC.

Pedersen, P. A. (1994). Regulating a transport company with private information about costs. *Journal of Transport Economics and Policy*, *28*(3), 307–318.

Perth Expert Reference Group. (1998). *Euro 2 and beyond: Fuel for transperth's bus fleet*. Report prepared for the Western Australian Minister for Transport, Perth.

Pettigrew, K., & Angus, P. (1992). High occupancy vehicle lanes in Sydney. Paper presented at the Biannual Conference of the Australian Road Research Board, Perth, November.

Pickrell, D. H. (1984). How many more rail systems does the U.S. need? Paper presented at the 26th annual conference of the association of college schools of planning, New York City, October 19–21.

Pickrell, D. H. (1991). Are they fulfilling their promise? *Transport News*, *156* (September – October), 3–5.

Pickrell, D. H. (1992). A desire named streetcar: Fantasy and fact in rail transit planning. *Journal of the American Planning Association*, *58*, 158–176.

Prefeitura da Cidade do Recife & Companhia de Trânsito e Transporte Urbano. (2001) *Transporte Informal – Diagnóstico da Cidade do Recife*. Recife: Prefeitura da Cidade do Recife & Companhia de Trânsito e Transporte Urbano.

Press, W. H., Flannery, B. P., Teukolsky, S. A., & Vetterling, W. T. (1986). *Numerical recipes*. Cambridge: Cambridge University Press.

Preston, J. (2001a). An overview of public transport reforms in Great Britain and forecasts for the future. *International Journal of Transport Economics*, *28*(1), 23–48.

Preston, J. (2001b). Regulation policy in land passenger transportation in Europe. Paper presented at the 7th international conference on competition and ownership of land passenger transport, Molde, Norway, June.

Preston, J. (2003). The road to Rio: A brief history of the international conference on competition and ownership in land passenger transport. Plenary paper for 8th international conference on competition and ownership in land passenger transport (Thredbo 8), Rio de Janeiro, September 12–19.

Preston, J. (2005). Contracting-out public transport planning: Options and prospects. *Plenary paper presented at the 9th International conference on competition and ownership of land passenger transport* (Thredbo 9), Lisbon, Portugal, September.

Preston, J., Huang, B., & Whelan, G. (2003). *Determining optimal bus service provision: Recent evidence from Great Britain*. Transport Studies Unit, University of Oxford and Institute for Transport Studies, University of Leeds.

Preston, J., & van de Velde, D. (2002). Competitive tendering of public transport: Theme A. *Transport Reviews* (Thredbo 6 workshop report).

Price Waterhouse Urwick. (1992). *Required revenue for school bus operations.* Report prepared for the NSW Bus and Coach Association, February.

Prioni, P., & Hensher, D. A. (1999). *Measuring service quality and evaluating its Iinfluence on costs of service provision.* Institute of Transport Studies, Faculty of Economics, The University of Sydney, Sydney, July.

Prioni, P., & Hensher, D. A. (2000). Measuring service quality in scheduled bus services. *Journal of Public Transport*, *3*(2), 51–74.

Pushkarev, B., & Zupan, J. (1980). *Urban rail in America: An exploration of criteria for fixed-guideway transit*. Report no. UMTA-NY-06-0061-80-1, U.S. Department of Transportation, Urban Mass Transportation Administration, Washington, DC, USA.

Pushkarev, B. S., & Zupan, J. M. (1977). *Public transportation and land use policy*. IN: Indiana University Press.

Richardson, A. J., Ampt, E., & Meyburg, A. H. (1995). *Survey methods for transport planning*. Melbourne: Eucalyptus Press.

Richmond, J. (2000). Trams 'are not the answer for cities'. *Times*, July 24.

Richmond, J. E. D. (1991). Transport of delight-the mythical conception of rail transit in Los Angeles. Paper presented at the joint international congress of the association of collegiate schools of planning and the association of European schools of planning, Oxford, July.

Richmond, J. E. D. (1998). *New rail transit investments – a review.* A. Alfred Taubman Center for State and Local Government, John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts.

Roberts, C. (2001). *Cross-modal ownership in passenger transport – the British experience since 1985.* Paper presented at the 7th international conference on competition and ownership of land passenger transport, Molde, Norway, June.

Ross, P. (2003). Introduction to project alliancing (on Engineering and Construction Projects). Paper presented to alliancing contracting conference, Sydney, April 30.

Roy, J., Brotchie, J., & Marquez, L. (1995). *A study on urban residential density vs. transport energy consumption.* Paper prepared for the EASTS conference, Manila, September.

Rubin, T. (1991). *Bus vs rail costs.* Memorandum, Southern California Rapid Transit District Office of the Controller-Treasurer, August 21.

Russell, W. (2000). *Audit review of government contracts: Contracting, privatisation, probity and disclosure in Victoria 1992–1999, an independent report to Government.* Victorian Government Publisher, Melbourne, May.

Salomon, I., Bovy, P., & Orfeuil, J. P. (Eds). (1993). *A billion trips a day: Tradition and transition in European travel patterns.* Dordrecht: Kluwer Academic Publishers.

Sansom, T., Nash, C., Mackie, P., Shires, J., & Watkiss, P. (2002) *Surface transport costs and charges: Great Britain 1998.* Institute for Transport Studies, University of Leeds, Leeds.

Seligman, M. (1975). *Helplessness*. San Francisco: W. H. Freeman.

Shleifer, A. (1998). State vs. private ownership. *Journal of Economic Perspectives*, *12*(4), 133–150.

Simon, H. A. (1982). *Models of bounded rationality: Behavioral economics and business organization*. Cambridge, MA: MIT Press.

Smith, N., & Hensher, D. A. (1998). The future of exclusive busways: The Brazilian experience. *Transport Reviews*, *18*(2), 131–152.

SMT. (1993a). *Corredor Santo Amaro-9 de Julho: Propostas de Recuperacao, Internal Memorandum*, Secretaria Municipal de Transportes, Sao Paulo (unpublished).

SMT. (1993b) *Programa da Corredores e Terminais de Intefracao,* Secretaria Municipal de Transportes, Sao Paulo (unpublished).

SOCIALDATA. (2003). *Travel behaviour change program for the City of South Perth under the TravelSmart Program – Technical Appendix, DPI WA*. DPI web reference www.dpi.-wa.gov.au/travelsmart/pdfs/ proposal.pdf.

Southworth, F. (1995). *A technical review of urban land use-transportation models as tools for evaluating vehicle travel reduction strategies, ORNL-6881*. Oak Ridge, TN: Oak Ridge National Laboratory.

SRA. (1994). *Cityrail: Strategic plan*. Internal Memorandum, State Rail Authority of NSW, Sydney (unpublished).

Stanley, J. (2000). Fuel choices for Australia's buses. Paper presented to the Australian Bus and Coach Association Conference, March.

Stokes, G., Carmen, H., Bradburn, P., Goodwin, P., Hallett, S., Bocker, G., Kenny, F., & Jones, P. (1991). *Buses in towns*. Transport Studies Unit, The University of Oxford, Oxford.

Stone, J. R., Allen, J. D., Moerz, A., & Gardner, B. (1992). Transit system evaluation: Guideway vs. light rail transit. *Journal of Advanced Transportation*, *26*(3), 213–240.

Stopher, P. R. (1998). A review of separate and joint strategies for the use of data on revealed and stated choices. *Transportation*, *25*(2), 187–205.

SUSTRANS UK (2002). http://www.sustrans.org.uk/

Swait, J., & Louviere, J. J. (1993). The role of the scale parameter in the estimation and use of multinomial logit models. *Journal of Marketing Research*, *30*, 305–314.

Swait, J., Louviere, J., & Williams, M. (1994). A sequential approach to exploiting the combined strengths of SP and RP data: Application to freight shipper choice. *Transportation*, *21*(2), 135–152.

Swanson, J., Ampt, L., & Jones, P. (1997). Measuring bus passenger preferences. *Traffic Engineering and Control*, *75*(June), 330–336.

Taplin, J. H. E. (1982). Inferring ordinary elasticities from choice or mode-split elasticities. *Journal of Transport Economics and Policy*, *16*, 55–63.

Taplin, J. H. E. (1997). A generalised decomposition of travel related demand elasticities into choice and generation components. *Journal of Transport Economics and Policy*, *31*, 183–191.

Taplin, J. H. E., Hensher, D. A., & Smith, B. (1997). *Imposing symmetry on a complete matrix of commuter travel elasticities*. Sydney: Institute of Transport Studies, The University of Sydney.

TAS. (1999). *Bus industry monitor 1999*. Preston: TAS Publications and Events.

Taylor, S., & Wright, R. (1984). An economic evaluation of Calgary's north-east light rail transit system. *Logistics and Transportation Review*, *19*(4), 351–365.

Theil, H. (1975). *Theory and measurement of consumer demand* (Vol. 1). North-Holland Publishers.

Thome, B. (2001). *Local public transport organisation in France: A new deal?* Paper presented at the 9th world conference on transport research, Seoul, July.

Ton, T., & Hensher, D. A. (1997). RouteInfo – a GIS based bus planning program for route planning and establishing minimum service levels. *Proceedings of the 21st Australasian Transport Research Forum*, *21*(Part 2), 869–884.

Toner, J. (2001). *The London bus tendering regime – principles and practicve*. Paper presented in Workshop A, international conference on competition and ownership of land passenger transport, Molde, Norway, June (Thredbo 7).

Train, K. (1986). *Qualitative choice analysis: Theory, econometrics and an application to automobile demand*. Cambridge: MIT Press.

Train, K., & McFadden, D. (1978). The goods/leisure trade-off and disaggregate work trip mode choice models. *Transportation Research*, *12*, 349–353.

Transport Data Centre (TDC). (2002). *Household Travel Survey Summary Report 2002: Sydney Statistical Division*. Report 2002/1, Transport NSW, Sydney.

Tye, W. B. (1987). *Encouraging cooperation among competitors*. New York: Quorum Books.

URBS. (1992). *RIT: Integrated transport network*. Urbanizacao de Curitiba S.A., Curitiba.

URBS. (1993a). *O Onibus Biarticulardo na Linha Norte-Sul*. Internal Memorandum, Urbanizacao de Curitiba S.A., Curitiba (unpublished).

URBS. (1993b). *Rede de Linhas Diretas-Ligeirinho Para Voce*. Urbanizacao de Curitiba S.A., Curitiba.

URBS. (1994). Discussions with delegation of Australian bus operators, Euclides Rovani, Diretor de Operacoes, Urbanizacao de Curitiba S.A., Curitiba, July 6 (Personal notes).

Van der Reis, P. (1997). Transportation surveys among illiterate and semi-literate households in South Africa. *International conference on transport survey quality and innovation*, Grainau, Germany.

Van de Velde, D. M. (1992). Classifying regulatory structures of public transport. Paper presented at the 6th world conference on transport research, Lyon, France.

Van de Velde, D. M. (1999). Organisational forms and entrepreneurship in public transport. *Transport Policy*, *6*, 147–157.

Van de Velde. (2001). The evolution of organisational forms in European public transport. Paper presented in Workshop A, international conference on competition and ownership of land passenger transport, Molde, Norway, June (Thredbo 7).

Van de Velde, D., Hilfering, P., & Schipholt, L. L. (2005). The evolution of tactical tendering in the Netherlands. Paper presented at the 9th international conference on competition and ownership of land passenger transport, Lisbon, Portugal, September.

Van de Velde, D., & Pruijmboom, E. (2003). *First experience with tendering at the tactical level (service design) in Dutch public transport*. Erasmus University Rotterdam – Transport Economics, The Netherlands.

Van de Velde, D. M., & Sleuwaegen, L. I. E. (1997). Public transport service contracts: Searching for the optimum. *International Journal of Transport Economics*, *24*(1), 53–74.

Victorian Auditor General. (1998). *Public transport reforms: Moving from a service to a system*. Report No. 5.

Viegas, J., & Macário, R. (1997). Public transport regulation as an instrument of urban transport policy. International conference on competition and ownership of land passenger transport, Institute of Transport Studies, University of Leeds, Leeds, May (Thredbo 5).

Viegas, J., & Macário, R. (2001) Pitfalls of competitive tendering in urban public transport. Paper presented at the annual UITP conference, London, May.

Wachs, M. (1993). Learning from Los Angeles: Transport, urban form and air quality. *Transportation*, *20*(4), 329–354.

Waddell, P. (1998). An urban simulation model for integrated policy analysis and planning: Residential location and housing market components of UrbanSim. Paper presented at the 8th world conference on transport research, Antwerpen.

Walker, T. (1997). *Recent developments in automatic fare collection*. Southern Cubic Pty Ltd, Adelaide, South Australia.

Wallis, I. (2003). *Contract incentives in urban public transport – appraisal of practice and experience to date*. Wellington, New Zealand: Booz Allen Hamilton.

Wallis, I., & Gale, J. (2001). Economic incentives to increase public transport patronage – the theory and the practice. Paper presented at the 7th international conference on competition and ownership of land passenger transport, Molde, Norway, June.

Webber, M. (1979). The BART experience – what have we learned? In: A. Altshuler (Ed.), *Current issues in transportation policy* (pp. 95–134). Lexington, Massachusetts: Lexington Books.

Wegener, M. (2003). Overview of land-use transport models. In: K. E. Haynes, K. J. Button, P. R. Stopher, D.A. Hensher (Eds), *Handbook on transport geography and spatial systems*. Elsevier Press, forthcoming.

Wentworth, W. C. (1997). *Trams in the Sydney CBD*. Unpublished memo, November.

White, P., & Brocklebank, P. (1994). Urban travel and the smartcard. Paper presented at smartcard conference, February.

White, P., & Tough, S. (1995). Alternative tendering systems and deregulation in Britain. *Journal of Transport Economics and Policy*, *29*(3), 275–289.

Williams, H. C. W. L. (1977). On the formation of travel demand models and economic evaluation measures of user benefit. *Environment and Planning*, *9A*(3), 285–344.

Williamson, O. E. (1975). *Markets and hierarchies: Analysis and antitrust implications*. New York: Free Press.

Williamson, O. E. (1979). Transaction cost economics: The governance of contractual relations. *Journal of Law and Economics*, *22*, 223–261.

Williamson, O. E. (1985). *The economic institutions of capitalism*. New York: Free Press.

Williamson, O. E. (1987). *Antitrust economics*. Oxford: Basil Blackwell.

Worcman, N. (1993). Trends: Boom and bus. *Technology Review*, *96*(8), 12–17.

Workcover New South Wales. (2003). Workcover News 52. *Workcover New South Wales*, Gosford, March–May.

Yvrande-Billon, A. (2006). The attribution process of delegation contracts in the French urban public transport sector: Why is competitive tendering a myth? In: R. Macário, J. M. Viegas, & D. Hensher (Eds), *Competition and ownership in land passenger transport (Proceedings of the 9th international conference on competition and ownership on land passenger transport)*. Oxford: Elsevier Science, Chapter 28.

This page intentionally left blank

SUBJECT INDEX

Agency theory, 110
Asset ownership, 109–113

Benchmarking, 22, 32, 35, 42, 48, 83, 116, 119, 137, 139, 140, 144, 221, 225, 278, 289–290, 293–297, 461
Bounded rationality, 54, 108, 110
Bus rapid transit, 2, 356
Busways, 279–406

CO2, 213, 218, 416, 454, 455
Choice models, 148, 151–156, 178, 195
Competitive tendering, 7, 15, 18, 25, 42, 46, 48, 51, 68–72, 77, 81, 105, 113–116, 138–140, 270, 274
Community service obligations (CSO), 27, 67, 89, 147, 225, 233, 412, 419
Consumer surplus, 35, 82, 93–95, 200, 219
Contract models
  Adelaide, 29, 30, 34, 56, 64–65, 109, 117
  Curitiba, 371, 373, 382, 386, 388, 392, 394
  Perth, 40, 109, 116
  Trans Santiago, 44, 467
Contracts
  Area size, 38, 40, 43, 48–57, 64–65, 118
  Area-wide, 259–276
  Duration, 114, 117–117
  Gross contracts, 7, 35, 43, 119, 143
  Incomplete, 107, 111
  Negotiated, 26, 30–35, 38, 40, 42, 116, 138–140
  Net contracts, 35, 119, 142
  Performance-based, 8, 27–30, 47, 54, 67, 76, 81, 84
  Quality, 72
  Service quality, 271
  Size, 114, 117–118
  Tender price, 119–120
  Tendered, 18–20, 27, 30–35, 109, 138–140
Corridors, 29, 43–45, 84, 117, 353, 357, 360, 371, 377, 379, 383, 390, 393, 395, 399, 400, 406, 410, 412, 416, 417, 420, 424, 436
Cost savings, 26, 31, 54–55, 69, 112, 114, 133, 135, 136, 356
Country studies
  Brazil, 26, 30, 33, 41, 42, 45, 354, 357, 380–404
    Curitiba, 355, 361, 380, 382–383, 386–387, 388–389, 390–391, 392–396, 401–402
    Port Allegre, 357, 380, 384–384, 387–388, 389, 391, 396–398, 402
    Sao Paula, 380, 384–386, 388, 389, 391–392, 298–400, 402–404
  Chile, 26, 29, 37, 43–45, 467, 468
    Santiago, 26, 29, 43, 466
  Netherlands, 11, 12, 61, 114, 412, 450
  New Zealand, 6, 35, 72, 74–76, 468, 474, 479, 480
  Norway, 11, 52, 69, 70, 72, 77, 84, 114, 140, 471, 472
    Hordaland, 7, 35, 69, 72–74, 82, 473
  Sweden, 68, 411, 450, 471

South Africa, 15, 16, 18, 19, 22, 26, 28–30, 34, 35, 41, 42, 466, 467
UK, 6, 11, 13, 35, 49, 96, 141, 367, 377, 379, 412, 417, 421, 436, 441, 450–452, 471, 479, 486

Efficiency
Allocative, 83
Cost, 6, 7, 9, 16, 18, 55, 81, 83, 88, 107, 115, 118, 221, 222, 245, 259
Technical, 222, 225
Elasticities
Choice, 150, 174–176, 178, 482
Cross, 79, 145–147, 150, 151, 154, 155, 157, 166, 167, 169, 170, 175, 176, 182, 185, 186, 188
Direct, 87, 145, 157, 169, 170, 173
Fare, 88, 145, 147, 150, 169, 173, 187
Ordinary, 150, 174–176, 178, 482
Service, 87
Environmental benefits, 68, 75, 77, 83, 104, 455
Externalities
Benefits, 35, 36, 70, 75, 77–79, 90, 93, 96–97, 142
Marginal external costs, 96

Fares, 28, 3, 47, 57–61, 62–64, 71, 78, 87, 89, 119, 131, 145–171, 186, 190–293, 386–388
Fleet size, 57, 88, 100–103, 198
Franchising
Melbourne experience, 123–144

Government funding, 34, 106, 116
Government reform, 136–138

Incentives, 7, 8, 14, 28, 33–34, 36, 45, 51, 70, 78, 84–86, 92, 97, 108, 112, 259, 422, 433
Incomplete contracts, 107, 111
Informal sector, 18, 21, 22

Land use, 10, 196, 197, 199, 368–372, 413
Light Rail transit (LRT), 355–364, 366, 368, 369, 371–375, 405, 421, 425

Marketing public transport, 375, 425, 440–441
Measuring performance
Global indicators, 276
Gross TFP, 223, 236–246, 248–252
Partial ratios, 116, 232–234, 236, 244, 245, 252
Minimum service levels (MSL), 27, 35, 70, 84, 104, 139, 143, 226, 247, 259, 434, 436
Monitoring, 2, 9, 10, 13, 20–21, 33–34, 39, 54, 108, 228, 259, 275–276

Networks, 9, 10, 33, 40, 47–49, 53, 57, 62, 117, 120, 124, 195, 202, 247, 259, 373, 400, 412, 419, 434, 437, 450
Niches, 57, 419–421, 440–441
Non-commercial contracts
Costs, 323–326
PwC model, 300, 303, 306–309, 311–315, 319, 321–323
Survey data, 300–303
The ITS model, 303–315, 321–323

Objective functions, 11, 81, 83, 93
Ownership, 5–14, 25, 105, 109–113, 388–389

Partnerships
Collaboration, 105–107
Cooperation, 80, 106–107, 141
Trust, 37, 40, 41, 106–107, 117
Passenger growth
Benefits, 57, 60–61
Prediction, 87–88, 195, 358
Patronage, 28, 31, 34–37, 60–63, 70, 75, 78, 81, 86–88, 92–94, 104, 108, 112, 119, 125–129, 134, 142, 170, 186,

221–223, 228–230, 248, 252, 354, 357, 362–368, 374–376, 385, 396, 445
Payment models, 35–39
Performance-based contracts, 8, 27–30, 47, 54, 67, 76, 81, 84
Privatisation, 11, 18, 81, 133, 137, 365, 385
Procurement, 28, 29, 31, 38, 105, 116, 120, 121

Quality contracts, 67–80, 81–104, 466, 472, 475, 477, 478
Quality partnerships, 3, 13, 14, 17–18, 21, 37, 69, 140–142, 209, 437, 472, 476, 478

Regulations, 10, 15, 18, 25, 30, 51, 83, 105, 247, 257, 354, 370–372, 382–386, 405, 406
Regulator
  Capture, 32, 40, 51, 136, 138
  Control, 102, 57–61, 67
Risk, 34, 134, 142–143, 314–318, 324–325
Risk sharing, 142–143

Safety, 22, 36, 67, 75, 125, 128, 135, 267, 417
Service design, 27, 37, 38, 43, 83, 120
Service effectiveness, 16–21, 53, 55, 106, 107, 118, 121, 141, 221, 223, 260, 261, 273, 279, 458, 476
Service quality, 15, 16, 18–21, 47–61, 88, 91–92, 113–114, 121–122, 132–133, 259–276, 279–283, 286–298, 458–460
Service quality index (SQI)
  Attributes, 19, 122, 260, 262, 269, 273, 279–283, 286–289, 293, 297
  Benchmarking, 289–290, 293–297
  Importance weights, 286–289
Stated preference
  Attribute packages, 280, 283, 286, 288–290
  Attributes, 280, 281, 286, 459
  SQI studies, 279, 280, 286
STO framework, 6, 9–11, 14, 120, 435, 437, 466
Subsidy, 27, 29, 31–32, 35, 44, 48, 78, 82, 84, 92, 98, 227, 412

Technology, 12, 53, 108, 199, 204, 362, 375, 386, 397, 414, 438, 441–442
Ticketing, 40, 52, 62–64, 86, 119, 125, 131, 135, 143, 401, 403, 434, 445, 452
Total factor productivity (TFP), 222–225, 236–256, 276
Trams, 32, 61, 69, 124–128, 141, 142, 353, 422–426
Transaction costs, 35, 53–55, 57, 58, 108, 117
Transitways, 353–377, 431, 436, 441, 452
Transparency, 32, 52, 107, 114, 115, 139
TRESIS, 95–212, 213–219

Urban form, 371, 405, 412, 413, 425
User preferences, 264–268

Value for money, 7, 11, 14, 25, 27, 38, 55, 70, 76, 77, 81, 105–122, 278, 377, 421, 452, 487