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Infrastructure Public-Private Partnerships

Decision, Management and Development

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Preface

Infrastructure systems are vital in providing the necessary conditions to foster growth and economic development and in increasing the livable conditions of populations. The way countries have chosen to develop their infrastructure systems is not consistent across the globe. There has been a trend toward increasing private sector participation in public service provision. Among the several models for integrating the private sector, public-private partnership (PPP) arrangements are gaining momentum.

Infrastructure systems are essential to economic development but require large availability of capital and specific know-how. For these reasons, governments are engaging in PPP projects all over the world. On the one hand, the private sector is looking for investment opportunities, particularly with low levels of risk, and on the other hand, governments need to develop new infrastructure systems and/or refurbish existing ones.

This book will address several issues. How can the robustness of the decision making process leading to the option of PPP be improved? How should the contracts be designed to enable them to address the uncertainty of infrastructure in PPP projects? How should PPP contracts be managed? How should the inevitable renegotiations be addressed? The main objective is to provide insight into current PPP practices but also to develop mechanisms to improve the decision making process as well as the performance of the PPP contracts, particularly in the medium and long terms.

It is possible to disaggregate the main objective into several smaller objectives, as follows:

- Analyze the current models to calculate the public sector comparator (PSC) and propose new methods to compute it;
- Improve the process of decision making leading to the choice of a PPP option;
- Improve contract design to accommodate uncertainty and improve risk management through the development of flexible contracts;
- Design the management contract principles and procedures so that the contract can be effective, helpful, and useful and allow the objectives of both partners to be achieved with the PPP project;

- Understand the main determinants behind the renegotiation of concession contracts;
- Develop guidelines to decrease the probability of renegotiation and minimize the harmful effects on social welfare.

This book is organized into six chapters around these key objectives. After the introduction, where the main features of the PPP model are presented and discussed, the second chapter concerns the decision making process leading to the choice of the PPP option, with a particular emphasis on the PSC. Once governments (central and local) engage in PPP arrangements, they face a second challenge – contract design. Thus, the third chapter will look into contract design from a new perspective – developing flexible contracts to cope with uncertainty. Most academic and empirical works have been focused on the phase of contract design, but little attention has been paid to the longest phase: contract management (the fourth chapter). These contracts are in force for 20, 30, or 40 years and are thus subjected to great uncertainty. Contract management becomes a critical issue. Academic literature and empirical data show that most contracts are renegotiated a few years after the initial agreement is reached. Thus, renegotiations become a critical issue for the success of the PPP model. This is the core of the fifth chapter. Finally, the conclusion presents a summary of the main contributions of this book as well as its policy implications. It also presents some directions to take for future developments in these fields.

Here is a brief synopsis of each of the chapters.

Chapter 1: Introduction to PPPs

Chapter 1 will be the introductory text of the book. It will contain some general information regarding PPP arrangements, namely, the definition, types of PPP projects, and models for private involvement in infrastructure provision. It will also discuss the economics of PPP as well as tools for choosing the best alternative, the risk issues and the world trend of PPPs. It is an introduction to the chapters that contain the main contributions of the book.

Chapter 2: Public Sector Comparator Calculation

This chapter will look into the definitions of the PSC and value for money (VfM) tests and provide an overview on when and how the PSC is used and calculated. The methodology followed will consist of the use of an international benchmark to analyze the main advantages and disadvantages of the several calculation methods adopted by governmental agencies, with a particular emphasis on the discount rate. This will provide a unique set of information for those working on the PSC, both

academics and practitioners. This chapter will also present and discuss some real case studies.

To the authors' knowledge, no other work has presented such detailed information on real PSC calculations and methodologies. Later, the research results will be used to identify and analyze the critical steps when performing a PSC calculation. Each of these tasks will be critically discussed, and their main existing alternatives will be presented while identifying the main benefits and pitfalls.

The research presents innovative contributions in two different areas: first, by shifting the calculation of the PSC from deterministic to probabilistic, and second, by developing a new model for calculating probabilities – Bayesian networks (BN). The shift from a deterministic calculation to a probabilistic calculation explicitly accounts for the uncertainty of the calculation. Most forecasts and cost estimations are flawed. Nevertheless, most practitioners and decision-makers base their decisions on a single number, although they are aware of the uncertainty surrounding the calculation. Two different models were used, Monte Carlo and BN, and while the first is relatively well studied and often used in cost estimation and forecast problems, to the authors' knowledge, the second has not been applied in this field until now.

Chapter 3: Improving Contract Performance: Contractual Flexibility

The literature on PPP contracts has often presented long term rigid contracts as the answer to uncertainty. In some way, the fact that a PPP project can be seen as a relationship-specific investment subject to bargaining and opportunistic behavior might justify the need for this type of contract, which intends to provide a more stable and predictable future. Nevertheless, this has also been observed for risk sharing between two agents but not so much for the value maximization of the project.

This chapter will focus on improving contract performance in uncertain environments. If uncertainty is taken as an assumption rather than as a fact, it could be used as an opportunity. However, this requires managerial flexibility. Risks will be identified, and flexible options will be created, always under the principle of developing solutions with practical application.

Increasing attention is being paid to measures aimed at reducing risk exposure, but most studies on this issue have been related to the financing aspects. This work will go a step further, first by identifying the possibilities for introducing flexibilities into a PPP contract, and second, by quantifying, through a case study, the economic gains of such a contractual design model.

This chapter will provide an overview on the main sources of risk and uncertainty in PPP projects, present the main types of flexibilities used in PPP arrangements based on a literature review, and present a new framework for

flexibility classification. This section will also revisit the main methodologies for flexibility valuation, and finally, a case study (healthcare PPP project) will be developed to analyze and economically evaluate the effects of developing flexible contracts. The last section provides the main conclusions of the research.

Chapter 4: Contract Management. How Important Is It?

The main objective of this chapter is to improve the current practices of contract management to comply with the aims of the contract, including decreasing the risk and the effects of renegotiation. To achieve this purpose, several tasks will be performed: (1) using an international benchmark of current management systems to identify the main benefits and pitfalls; (2) developing a dynamic model for the active management of contract performance based on the three dimensions of contract management, which are operational management, administrative management, and relationship management; and (3) presenting and discussing the best practices of the internal aspects and key activities of contract management.

This chapter is also intended to contribute to the clarification of the role of several stakeholders involved in contract management, particularly the "contract manager" and the regulator. The improvement of current management systems will have to take into account the issue of renegotiations because the management of this process is one of the most critical aspects for the success of the concession model.

Chapter 5: The Problem of Renegotiation. What Are the Determinants? How Should a Renegotiation Be Managed?

This chapter aims to provide answers to the following questions: How and why do renegotiations happen? What are the main determinants? How can the risk of renegotiation be avoided or controlled? To allow for a deeper and structured analysis, the main determinants for renegotiations are categorized into two groups: exogenous and endogenous variables. Exogenous variables refer to the project's characteristics (dimension, complexity, sector, etc.), while endogenous variables refer to the contractual clauses, for example, the existence of a clause ensuring a determined (shareholder or project) internal rate of return (IRR), limiting the value at risk (VaR). This chapter is organized as follows: after a brief introduction, the literature on renegotiations will be reviewed; next, the exogenous determinants of renegotiations will be discussed, identifying the main determinants through an econometric model, followed by the text on the endogenous determinants of renegotiations; the main causes, results, and costs of renegotiations will also be examined; the "economic and financial re-equilibrium" (EFR) model will be presented as an alternative to tackle uncertainty; finally, the last section will present the main findings and policy implications.

Chapter 6: Conclusions

The final chapter will present the main findings of the analyses developed as well as several further developments in each of the following focus areas: PSC, flexible contracts, contract management and renegotiations. In addition to the contributions described, several paths that we believe are promising research areas for those researching PPP contracts are presented. Additionally, some policy implications are developed over several areas for those working with PPP projects in a real context.

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Acronyms

ADB	African Development Bank
BAA	British Airport Authority
BAFO	Best and Final Offer
BN	Bayesian Networks
CAPEX	Capital Expenses
CAPM	Capital Asset Pricing Model
CBA	Cost Benefit Analysis
CBR	Cost Benefit Ratio
CCF	Capital Cash-Flow
CFA	Contractual Flexibility Analysis
CPI	Consumer Price Index
DCF	Discount Cash-Flow
DFBO	Design-Finance-Build-Operate
DSCR	Debt Service Coverage Ratio
DSM	Design Structure Matrix
DT	Decision Trees
EFR	Economic and Financial Re-Equilibrium Model
EU	European Union
FCF	Free Cash-Flow
GDP	Gross Domestic Product
HSR	High Speed Rail
IRR	Internal Rate of Return
ISO	International Organization for Standardization
KPI	Key Performance Indicator
LCCA	Life-Cycle Cost Analysis
LLCR	Loan Life Coverage Ratio
LPVR	Least Present Value of Revenues
MIG	Minimum Income Guarantee
NCSL	National Conference of State Legislators
NHS	National Health System
NN	Neural Networks
NPV	Net Present Value

OBC	Outline Business Case
OPEX	Operating Expenses
PFI	Private Finance Initiative
PPC	Public Private Comparator
PPP	Public-Private Partnership
PSB	Public Sector Benchmark
PSC	Public Sector Comparator
RDM	Revenue Distribution Mechanism
RHS	Reshaping Health Services
RO	Real Options
UK	United Kingdom
USA	United States of America
VaR	Value at Risk
VAT	Value Added Tax
VfM	Value for Money
WACC	Weighted Average Cost of Capital
WB	World Bank

Introduction 1

1.1 Preliminary Remarks

Public-private partnership (PPP) arrangements have emerged all around the world as a response to infrastructure deficits and the need to refurbish existing infrastructure. There is no unique and clear definition of PPP, but it is possible to summarize it as a procurement model for the provision of infrastructure and/or services. The public and private sectors engage in a contractual, or institutional, relation to ensure that a certain infrastructure and/or service is available to citizens.

This is one of the main features of PPPs. They are generally developed for public interest missions: roads, railways, ports, airports, water and wastewater, waste, energy, health, security and prisons, to give some examples. The government, the ultimate guardian for the provision of these services, entrusts the private sector with the responsibility of designing, financing, building and operating the infrastructure and/or service. There are several models, as will be explained later, where not all responsibilities are assigned to the private sector. For example, the financing and design can be retained by the public sector.

PPP arrangements have become a solution to overcome public budget constraints while allowing for the use of the private sector expertise and know-how to deliver and manage public services. Although the main driver for developing PPP contracts should be a greater efficiency in the use of public money, the fact is that most PPP projects are developed as a bypass to public budget constraints. In the medium and long term, this has raised several problems, particularly through renegotiations, which have increased the financial burden with this procurement model.

PPP projects are thought to have developed in the 1990s in the United Kingdom (UK). Indeed, this is true given the current complex structure of project finance. However, as a form of agreement between the public and the private sector, where the latter assumes responsibilities usually placed at the government level, it is far older. It is possible to find "concession models" in the fifteenth century, where the

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grantor (the King) would allow navigators to explore unknown territory in return for rent.

The model has been extensively used since 1990, first in countries such as the UK, Canada, Australia, Spain or Portugal, among others, and more recently, all over South America, Asia, Africa and the United States of America (USA). Why is this model gaining momentum? What does it provide to the governments? Is it risky? What happens if things go wrong? What are the types of PPP models? These and many other questions will be answered in the following sections in this book.

1.2 Models for Private Involvement

Traditional procurement models take the form of public work contracts. The private sector delivers a pre-designed service ordered by the contracting agency (public entity), and its unique responsibility is related to the quality standards (established for the service itself). The relationship between the two agents is an agency-contractor transaction. The complexity of these traditional models may increase when there are technical assistance contracts or sub-contracting, in which the private partner is responsible for the provision of a certain service that is part of a larger system, for example, cleaning services in a healthcare facility. At this point, a deeper involvement of private agents goes into the PPP domain.

Management contracts, leasing or concessions of PPPs are more complex than traditional procurement models (Gómez-Ibañez 2003). In the first model, the private partner receives a management fee, generally indexed to a performance target, for running a service on behalf of the public agent. In the second model, known as leasing, the private agent, who manages and runs the service, pays a lease fee to use the public infrastructure and assumes the business risk, but the agent is not responsible for investments.

In the European Union (EU), the concessions are categorized into concessions of public works and concessions of public services. The difference between them is that in the former the bulk of the business concerns the construction works, and in the latter it regards the provision of the public service. Finally, there are also concession models built in different forms (build-operate-transfer, BOT; build-own-operate, BOO; etc.). The private agent not only assumes the total (or partial) business risk but also engages in investments to upgrade or increase the infrastructure capacity. Although it should not be considered a PPP project, divestiture or privatization model is the ultimate level for private engagement in service provision because the government abandons the service provision process and keeps, in most situations, only a regulatory role (Koch and Buser 2006; Devapriya 2006).

Table 1.1 shows the different arrangements for private sector involvement in infrastructure provision. Theoretically, this categorization clarifies the different relationships established, but reality suggests a far more complex set of models, especially concerning issues such as asset ownership, risk allocation (incentives for efficiency) or investment decisions.

Table 1.1 Models for private sector involvement in infrastructure provision

Private sector involvement	Description	Asset ownership
Public work contracts	Private sector only performs pre-determined tasks to the service provider with no responsibility for the final service quality	Public
Technical assistance contracts	Continuum contracts between private and public sectors to ensure an adequate quality level in a sub-system	Public
Sub-contracting or outsourcing	The public sector contracts a private company to provide a certain service, for which the private sector is entirely responsible	Public
Management contracts	Based on a set of objectives and targets, the private sector manages the service for the "owner"	Public
Leasing (Affermage)	The private sector assumes at its own risk the provision of the service, for which the public sector pays a lease fee. It is not responsible for making investments	Public
Concession (BOT or other schemes)	The private sector is responsible for providing the service and also for financing the investments required. After the concession period, the assets come back to the public sphere	Public
BOO	The same as BOT but without the transfer at the end of the period	Private
Divestiture[a]	Complete transfer of assets from the public sector to a private entity	Private

Source: Adapted Cruz and Marques (2011)
[a]Divestiture can be divided into divestiture by sale and divestiture by license

The development of PPP arrangements is often noted as a process of privatization. Privatization in this context refers to the involvement of the private sector in the provision of public services. In fact, the core of privatization processes is distinct from PPP projects. In privatization processes, as occurred with the British Airport Authority (BAA), there is a definitive transfer of the ownership of the assets. The government sells the asset. In PPP projects, the ownership remains in the public domain, or there is a reversal of ownership at the end of the contract. For example, the Australian and Argentine airports were not fully privatized, but instead, the concessionaire had a fixed-term lease.

Considering the portfolio of models for the private involvement in infrastructure provision, the public work contracts are at the opposite side of privatization. In the former, the private sector only assumes the risk inherent to the construction of the infrastructure. The public sector contracts a pre-established service, exhaustively specified, and the private sector is responsible for delivering the product complying with the specifications. This approach is entirely different from the PPP options, which are, or should be, focused on the outputs, while public work contracts are focused on the inputs.

This distinct approach can also be observed from a risk-sharing perspective. In PPP projects, risk allocation is far more complex. In public work contracts, all risks are retained by the public sector (with the exception of the construction risk). In full

privatization, the private sector assumes almost all the risks, while in PPP projects, the risk is usually shared by both parties. Ideally, the private sector should assume a substantial part of the risk, mainly because this risk exposure should stimulate the private sector to deliver more innovative and efficient solutions.

Notwithstanding, there are completely different models within the PPP "umbrella". The next section will discuss them in detail.

1.3 Types of PPP

There are several types of PPP arrangements and several classifications according to different authors and institutions. One of the most widely used is the one adopted by the EU that splits PPP projects into two different types: institutional and contractual.

Institutional PPPs are those where the public and private sector are shareholders of a third entity, often specifically created for the project. The management of this entity is usually under the responsibility of the private sector, although different frameworks are possible: the public sector has the majority, both have equal shares (50–50) or the private sector has the majority.

In contractual PPPs, the two agents are engaged through a contract. The contract specifies the responsibilities, rights and obligations of each party, and it determines the level of service to be provided through an investment plan. Furthermore, the contract may or may not include rules for dealing with contingencies, and it should also include the rules for early termination, penalties and compensations, among many other features.

Allen (2001) categorizes PPP projects into three different types: freestanding projects, in which the concessionaire recovers the full costs on user charges (many PPP projects in the water sector, roads and ports, belong to this type); joint ventures, in which there is a contribution from the public sector, even though the concessionaire is the one directly responsible for the project; and services sold, in which the public sector is the unique funding source, paying a fee for a service that is provided by the private sector.

Hammani et al. (2006) and the World Bank (WB) propose a four-category classification: management and lease contracts, concession, greenfield and divestiture. Divestitures are full privatization processes and therefore should not be classified as a PPP model. Nevertheless, for these authors, divestitures are a form of private sector participation in the provision of public services and, therefore, should be considered. This classification can raise several doubts, but it is still a current form of categorization.

Irrespective of these categories, the most widely used are those related to the contract structure. They are presented in Table 1.2.

This classification depends mostly on two criteria: the different stages considered in the partnership (design, construction, maintenance, etc.) and the relationships with the asset (ownership versus rent/lease). It is not rare to find different acronyms for the same model, e.g., DBFO and DBFOM (design, build,

Table 1.2 Models of PPP projects

Acronym	Designation
BOM	Build-own-maintain
BOO	Build-own-operate
BDO	Build-develop-operate
DCMF	Design-construct-manage-finance
DBO	Design-build-operate
DBFO	Design-build-finance-operate
BBO	Buy-build-operate
LDO	Lease-develop-operate
BOT	Build-operate-transfer
BOOT	Build-own-operate-transfer
BROT	Build-rent-own-transfer
BTO	Build-transfer-operate

Source: Adapted OECD (2008)

finance, operate and maintain). Both models include maintenance, and it is assumed that for both acronyms the operation will include maintenance of the assets.

1.4 The Rational for PPP Project Usage

Some argue that the PPP model allows for the government to focus the scarce public resources on areas not covered by PPP projects or that the competition and the scrutiny of capital markets by the private sector makes the use of capital resources more effective (Guasch 2004; Engel et al. 2009a). This debate is not immune to ideological discussions on what should be the role of the government in today's economic and social context. Those more liberal believe that the role of the government should be minimal and limited to supervision and regulation, while others believe that the government should be a provider in some special public interest areas. Nevertheless, this ideological debate should not dominate the decision making process for selecting the best procurement model. The main rationale behind PPP projects is efficiency. PPP proponents claim that this procurement model boosts efficiency, which can be measured through Value for Money (VfM) tests, i.e., the quantification of the efficiency of the PPP model in comparison to traditional procurement models.

As Engel et al. (2009a) claims, it is clear that PPP arrangements have the merit of bringing competition to infrastructure provision.[1] However, the "*off balance sheet*" status of this model, often unaccounted for by the public deficit calculation, leads to an abuse in the usage of this procurement methodology to the point of allowing for

[1] Competition in infrastructure provision might be categorized into competition *for* the field and competition *in* the field, as discussed in Demsetz (1968a).

economically impracticable projects to go forward because the government guarantees the return of the investor by assuming all (or most of) the commercial risks. The premise for PPP project usage is a significant risk assumption by the private party (Bennett and Iossa 2006; Meda 2007). It is because of risk exposure that the full potential of efficiency gains is leveraged, though risk aversion by the private sector should be expected (Moles and Williams 1995).

The "protection" of some projects by the government, which guarantees a risk-free continuous cash-flow throughout the project's lifespan, is meritable because the PPP model rejects projects with a negative net present value (NPV). The private sector's ability to evaluate projects allows it to focus on those with an expected positive NPV.

1.5 Main Benefits of Using PPP Projects

With this procurement process, there are advantages for both parties. In fact, the parties have two different concerns. The private concern is the profit-driven return on the investment for risk-taking and the fulfillment of business purposes. The public concern is more complex, driven by legislation, regulation and authorities, political opinion, democratic decision making, minimizing the risk and maximizing the social value (Jones 1994).

As a result of this alliance, there can be a mutual added value because the private partner gets a profit and the public partner reduces its costs for infrastructure development and public service management. With the aim of increasing fiscal restraint and without jeopardizing the quality of the service provided, governments are appealing to the private sector expertise and financing ability of their private partners. Especially in projects that require large up-front sunk investments, such as roads, dams, railways or seaports, the PPP option allows the "bill" to be paid over time. When user revenues are enough to cover investments and operation costs, no additional expenditure is required from the government. This can be found, for example, in retail water systems.

In other cases, for example, "shadow tolls" highways, the government pays a fee to the concessionaire during the contract. There are other advantages in using this procurement model. Despite the lack of irrefutable evidence on the benefits of private over public management, there is consensus that the probability of cost overruns and time delays under private management are significantly lower than when directly managed by a public body (Grimsey and Lewis 2002). In large-scale investments, this could be enough to justify the adoption of a PPP arrangement, though the decision on whether to use a PPP project is far more complex. This issue will be developed in detail in Chap. 2.

1.5.1 PPPs Are Oriented Toward Satisfying Global Needs

Most PPP projects are established for the provision of public services, with transportation, water, waste, health care, security, energy and education being the most relevant. These infrastructure and public services aim at satisfying the needs of the population and can be observed as services of great public relevance and as fundamental for economic and social cohesion. This is one of the reasons why, even under a PPP scheme, the government is ultimately responsible for these services. The service can be provided and managed by a private entity, but the government retains the responsibility of ensuring that the service is affordable, accessible, meets the population needs and the quality standards and is efficient in the use of public expenditure.

1.5.2 PPPs Involve Long Term Relationships

Most PPP projects involve large and sunk investments. To allow the concessionaire to recover these investments and obtain its profit rate, it is necessary to have long term relationships. These can be as long as 50 years (e.g., airports in Argentina), but 30-year durations are the most common.

The establishment of a long term relationship might be positive in the sense that it allows for stability in the organizational and legal framework of the service being provided. Nevertheless, experience has shown that this often results in contract incompleteness and renegotiations. The longer the contract, the longer it will take for re-bidding and to capture the benefits of competition. There is a trade-off between the period required to allow for the full recovery of the costs and the benefits of shorter contracts that allow for frequent re-bidding. This will be discussed later, but when defining the time required for cost recovery, an important question emerges: why fully amortize most infrastructure investments in 30-year contracts when most of these infrastructure have a lifespan of at least double this period? In fact, there has been some discussion on allowing for shorter contracts without increasing their costs (Viegas 2010).

1.5.3 PPPs Involve Total or Partial Financing of the Project

Although not mandatory, PPP arrangements generally involve financing of the project. This financing can cover all costs or partial costs. Why is it important to have at least partial financing of the project? To foster efficiency, the concessionaire needs to have incentives. These incentives can be linked to performance-based compensations and also, indirectly, through Value at Risk (VaR). This means that if the concessionaire invests equity from the shareholders, he will have an extra incentive to perform as efficiently as possible and avoid at all cost a bankruptcy situation or, at least, any losses.

1.5.4 PPPs Are Oriented Toward Results

Ultimately, the success of the PPP project is measured by the results. A good PPP is focused on the outputs and on the maximum efficiency to achieve those outputs. Unlike traditional procurement models, which are generally focused on the "product", meaning that there is a comprehensive specification of the materials, techniques, design standards, technical specifications, etc. to be used, in the PPP model, the grantor should be focused on defining what service the PPP arrangement should provide and what the characteristics of that service should be.

1.5.5 Bundling Several Stages of the Project

The design, construction and maintenance of large infrastructure such as roads, hospitals, dams or airports is an extremely complex process and is highly vulnerable to cost and time deviations.

Much of these problems are due to the incoherence between phases; for example, during construction, errors may be detected in the designs. It is not easy to allocate responsibilities, and most of the time, misallocation results in time overruns and costly disputes. For the grantor, contracting each stage separately can also lead to higher transaction costs because there are more public tenders to launch and more contracts to manage.

Therefore, bundling all project stages can result in synergies and cost efficiency. Figure 1.1 illustrates a simplified version of an infrastructure life-cycle.

The planning stage involves all preliminary studies (cost benefit analysis – CBA) as well as a large draft of the project features. The design involves the technical specification of the project at a level that will allow a posterior construction. In large-scale projects, it is not unusual for these two stages to take between 3 and 5 years when there is political commitment. This can increase to several decades when there is no political consensus around the project. The construction involves all related activities and generally takes 2–3 years depending on the complexity. For example, a road is typically simpler than an international airport. This stage also includes all tests and quality certification (commissioning) of the infrastructure and its components. Once again, for a hospital or an airport, this can take several months. Finally, the operation is the longest stage. In addition to the operation itself, construction includes, among other items, all maintenance activities, infrastructure improvements and increases of capacity.

These synergies are more evident in two interfaces: first, design <->construction, and second, construction <-> maintenance, as discussed by Cartlidge (2006). In the first case, the interface concerns the problems and changes of the project that are detected in the construction phase and that require an update and revision of the project. When this is performed by the same entity, or by different firms under the same consortium, it becomes more effective and easy than when it is performed by separate entities because there is more concern about charging over costs. The second interface concerns the adoption of construction methods and materials that

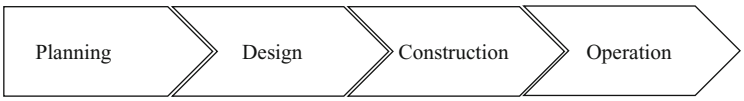

Fig. 1.1 Infrastructure life-cycle

minimize, or optimize, the maintenance (or operation) phase. In other words, when the entity that builds the infrastructure is responsible for the operation/maintenance over the next 30 years, it is more likely to adopt techniques minimizing the whole life-cycle cost rather than search for short run profits.

1.5.6 Enhances Innovative Solutions

As mentioned earlier, PPP projects are oriented toward results. When the concessionaire has the proper incentives, he may be able to deliver innovative and higher-value solutions. This is one of the main objectives of the PPP arrangements. However, for this to happen, it is necessary to include an effective risk transfer in the contract. Only if the concessionaire has an effective pressure of losses will he be encouraged to optimize the resources to deliver the best VfM solution. Under traditional procurement methods, the creativity is dependent solely on the team that designs the bid.

The most relevant aspect regarding innovation is the ability of the concessionaire to adopt innovative solutions in the design phase that will allow for greater efficiency in the life-cycle management. When the design phase is contracted alone, the project designers do not have the incentive to think long term or, particularly, to adopt solutions that will minimize the life-cycle cost. If the project is being designed by the same company (or consortium) that will operate the system, there will be a continuous search for the most economical solution. This is one of the great advantages of bundling the several stages of an infrastructure life-cycle.

1.5.7 Allows a Life-Cycle Cost Perspective

One of the problems found in many large infrastructure investments is the poor accountability. The adoption of the PPP model allows for having a full life-cycle cost perspective. When the bidders prepare their proposals, they are committing themselves for a very long period and, therefore, try to obtain the most accurate estimates of costs. By bundling the several stages of the infrastructure, the PPP model accounts for the whole life-cycle costs and for assigning the corresponding responsibilities of the different actors (designers, contractors, etc.).

1.5.8 Allows for More Effective Control of Costs and Deadlines

One of the main rationales of PPP adoption is the idea that the private sector is able to control costs and deadlines more effectively than is achieved by traditional procurement. As mentioned earlier, for this to happen, it is necessary that the private sector is entrusted with significant risks, particularly those related to construction. This happens in most PPP projects. The private sector is the main, or the only, sector responsible for the construction risk. Construction cost overruns are well known all over the world. Traditionally, public work contracts cost significantly more than expected, usually without compliance with deadlines (Flyvbjerg et al. 2003).

1.5.9 Attracts More Competition at a Global Level

PPP tenders are larger than public works tenders. This is because PPP projects involve the whole life-cycle, and therefore, the turnover of these contracts is greater than those of construction. Even in infrastructure such as roads, where construction is the main activity, if one considers the entire life-cycle costs for 30 years, construction can be just half of the total costs.

By having larger tenders, small companies have more difficulties in bidding, but larger and multinational companies become more interested. Considering that the purpose is to ensure the highest levels of efficiency, this will be an advantage because there will be greater competitiveness (the global market is always larger than the local market).

1.5.10 Allows Governments to Focus on Their Main Tasks

Governments have a variety of tasks to perform. They are responsible for maintaining a country's policy toward prosperity, wealth and security, always bearing in mind an efficient use of the taxpayer's money. This is not always compatible with the direct management of infrastructure and services, which requires a more active and commercially driven approach. By transferring this direct management responsibility to private companies, governments can be focused on ensuring, from a public policy perspective, that the services meet the needs of the population.

In fact, one may argue that PPP projects, or full privatization processes, allow for clarity in the role of the government. The government should monitor the services and assure that they respond to the population's and society's needs in the most efficient possible way. If this does not happen, it should act by applying penalties. When the government provides the services directly, it can be difficult for it to apply penalties to itself. By delegating the responsibility of service provision to a private entity, the government can focus on its supervisory role. This should be performed at two different levels: a pure regulatory role and as a contract manager.

As a regulator, the government should ensure equity, fairness, foster competition and avoid monopolistic abuses, while as a contract manager, it should guarantee that the service is provided according to the contract and protect the public partner.

1.5.11 Ensures Effective and Dynamic Management of Infrastructure and/or Services

The commercially driven approach of the private sector, oriented toward results, ensures a more effective and dynamic management of the infrastructure and/or service. Naturally, some types of infrastructure/services are more prone to this dynamic management. For example, hospitals and clinical management require more active management than a highway, where the service is more "rigid" and technologically less dynamic.

1.5.12 Supports the Development of Large Infrastructure Plans

The PPP model is the preferred model by governments when it is necessary to develop large infrastructure programs. Several examples can be found, such as President Obama's 50 billion dollar infrastructure plan or the recent infrastructure plan developed by the President of Brazil. This happens for essentially two reasons: private capital availability decreases the short term pressure on public budget and the ability of the private sector to manage and leverage all these projects, which is impractical under traditional procurement.

1.5.13 Diversifies the Market for the Construction Industry

Although this is not a direct benefit of the PPP model, the truth is that this procurement scheme allows for diversifying the market for the construction industry, ensuring a more constant demand for its services because it engages in the maintenance of the infrastructure for the entire lifespan of the project. It also allows for a more rational distribution of investments over time in long term projects.

1.6 Main Pitfalls in PPP Usage

The development of PPP arrangements has been far from perfect. In fact, the need felt by governments to develop projects without public expenditure has led to poorly designed contracts and, eventually, to the delivery of projects without a positive NPV, even when considering social and larger economic benefits. Ad hoc renegotiations become inevitable and result directly from the lack of preparation of public authorities (Engel et al. 2009a). These renegotiations take place during the contract period, meaning that there will be only one price, the one presented by the

private partner, without any competition and with profit margins that may be, and generally are, well above those observed in a competitive market. The companies competing for the contract sometimes plan to engage in this abusive behavior. Engel et al. (2009b) found evidence of firms lowballing their offers to levels of predatory prices, expecting to reach their desired levels of profitability during renegotiations. For example, in the construction of the Portuguese highway network, there are examples of renegotiations even before the highway was open.

1.6.1 Higher Cost of Capital

PPP projects often include the total or partial financing of infrastructure. However, private financing is frequently more expensive than public financing.[2] This is attributable to the fact that with public debt, the risk is spread over the entire society, which is why public borrowing is usually perpetuity, with the debt being rolled over. Private borrowing narrows the risk exposure to an individual (or a limited group of individuals), and therefore, it is more risky from the perspective of the capital borrowing market. This distinct valuation of risk by financial markets leads to a higher cost of financing in PPP schemes when compared with traditional public budget funding.

1.6.2 Contractual Incompleteness

Contractual incompleteness has been one of the main weaknesses identified in PPP arrangements both at a theoretical and an empirical level. Contracts are necessarily incomplete. Because of the long duration of most PPP projects and the complexity of these projects, the probability of events for which there is no contingency plan is very high. This requires the contract to be re-adapted to these new unveiling circumstances. From a theoretical point of view, there is no a priori problem, but the reality shows that when renegotiations occur, there is a high probability of biased results harming the public interest. This issue will be further developed in Chap. 5.

1.6.3 Difficulties in Long Term Forecasts

No matter the level of sophistication of the econometric models, forecasting for 30 or more years is an impossible task. In the case of PPP projects, this is particularly important because they are extremely vulnerable to the macroeconomic context.

[2] In the years 2011 and 2012, there was a crisis affecting the sovereign debt of some European countries that may jeopardize this statement. Nevertheless, this should be seen as an extraordinary event.

This impacts not only the operating expenses (OPEX) and capital expenses (CAPEX) but also the revenue side. For instance, in the case of water concessions, an economic crisis may not have a substantial impact on consumption, but in the case of road concessions (and the impact on demand), the same principle does not apply. Furthermore, if the collection ratio is considered, both are affected.

1.6.4 Regulatory and Contract Management Capture

Regulatory and contract management capture are expressions used when the regulator or the contract manager is not impartial and attributes a disproportionate weight to a particular group of interests. This can happen in either institutionalized or contractual PPP arrangements and particularly affects those countries with lower levels of transparency, accountability and ethics in the public administration.

1.6.5 Bypass to Public Budgets/Overspending

Although the rationale for PPP use should be a higher VfM, the reality shows that this model has been used to bypass budgetary constraints. This is because of two distinct reasons. First, the expenditure with PPP projects, particularly sunk investments, is diluted over a long period of time, unlike traditional procurement where it is concentrated in a relatively short period (typically 2–3 years). Public bonds can overcome this shortcoming, but this is considered public debt, which leads to the second reason. According to the current EU public accounting standards, most PPP expenditures have not been accounted as public debt. This has created an opportunity for governments to engage in expenditure without the proper accounting. It is important to remember that the EU Stability and Growth Pact imposes on national governments a 3 % limit on annual public budget deficits. Similarly, concerning EU funds, there has been a European political guideline for the development of PPP projects. Naturally, this leads to an abuse of the PPP model to surpass budget constraints, and this has been particularly acute in some Mediterranean countries such as Portugal, Greece, Spain and Italy.

1.6.6 Transference of Costs to Parent Companies

PPP schemes are usually implemented using a special purpose vehicle (SPV), where the members of the consortium are shareholders. A phenomenon that has been observed in several PPP projects is the fact that many holding companies shareholders of several SPV entities are shifting costs to these companies. These holding companies often have several companies providing services to the SPV at prices well above average market prices. It is usual to find SPV with poor annual results, while the holding companies have large profits.

1.6.7 High Transaction Costs

PPP projects have high transaction costs because they require highly skilled professionals and a continuous management of the partnerships from the public sector side. In large PPP projects, the value of these transaction costs is small when compared with the total expenditure, but in local PPP arrangements, this can be a barrier to the development of successful partnerships. This is an important issue because local governments often cut spending with technical staff, which may lead to the development of ineffective and inefficient PPP arrangements with negative long term consequences for the public interest.

1.7 The Decision Making Process in a PPP

The decision making process of a PPP arrangement is complex and involves several stages. Figure 1.2 illustrates the decision making process of a PPP project, which can be divided into three levels: strategic, tactical and operational. In each of these levels, different analyses are performed to address different questions. The first question to be answered is whether the project should be developed, irrespective of the procurement model. Both the costs and benefits of the project (direct and indirect) should be carefully analyzed through a CBA and through the calculation of the corresponding cost benefit ratio (CBR). If, on the one hand, the CBR is lower than 1.0, it means that the costs of the project exceed the benefits, and therefore, the project should not be developed. If, on the other hand, the CBR is higher than one, the project should be developed because it represents an increase in the social welfare. A CBR equal to 1.0 is a theoretical scenario in which the costs equal the benefits.

The project should only go forward if the CBR is higher than one. In the next stage (tactical level), it is necessary to choose the procurement model. If the PPP arrangements are a procurement model alternative to traditional procurement, there is the question of deciding between the two. One of the main tools used worldwide is the Public Sector Comparator (PSC). The PSC can be defined as the cost of developing a project under a traditional procurement model by incorporating efficiency gains. PSC and VfM are often used interchangeably. However, they are different concepts. VfM tests can include qualitative techniques, while the PSC is a quantitative test. Nevertheless, with all the fragilities in its calculation, as will be discussed in Chap. 2, the PSC remains the most widely used tool. To calculate the PSC, it is necessary to estimate the cost of building, maintaining and operating the infrastructure for a pre-determined period equal to the expected duration of the PPP contract (CAPEX and OPEX). This value needs to be adjusted to account for the risk assumed by the public sector and also for the efficiency gains that should be expected by the public sector. If this value is higher than the PPP alternative, then the PPP arrangement offers VfM and, therefore, should be adopted.

The operational level is conducted simultaneously with the tactical level. Operationally, it is necessary to define certain PPP features, particularly, whether the

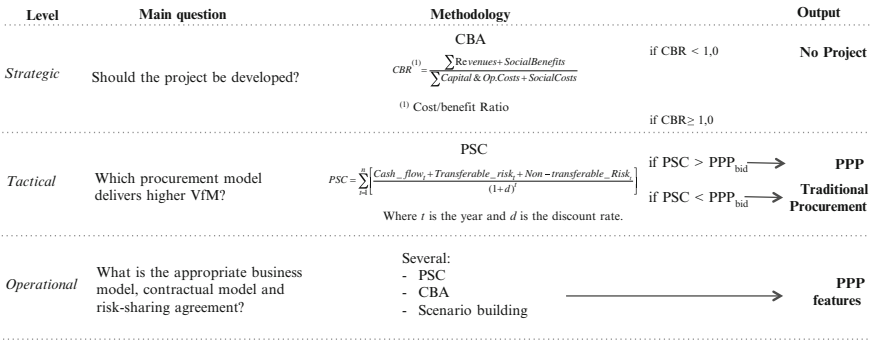

Fig. 1.2 Decision making process in PPP projects

PPP project should include both the construction and the operation, the duration of the contract, the risk-sharing agreement and all the features that will have a direct impact on the NPV. All these features are necessary to calculate the PSC. The fundamental question at this point is as follows: what is the appropriate business model, contractual model and risk-sharing agreement?

This structured process does not always correspond to reality. In many cases, governments recognize that the project will only go forward if it is developed under a PPP model because there are no available public funds to support the project. In some countries, such as Brazil, the PSC is not even calculated because there is a political commitment to the model. This should not be considered a good example for decision making. Although several of these stages might be less structured than described, it is important to ensure that the project analysis provides the answer to all these questions. The simple exercise of calculating the PSC allows governments to have a better understanding of the problems and costs affecting the project.

1.8 Life-Cycle of a PPP Project

The life-cycle of a PPP project can have more or less phases depending on the specific project, type of PPP model and country legislation, among other variables. Nevertheless, from a simple perspective, a PPP project can be divided into two large phases: pre-contract signature and post-contract signature. Figure 1.3 presents a scheme for a PPP project life-cycle with each partner's main responsibilities.

The signature of the contract is a milestone that formalizes the engagement between the public and private sectors. However, the process usually starts many years (in large projects, even decades) before the contract signature is obtained. The life-cycle begins when someone has a rudimentary idea for a project, which often results from the identification of a need or problem. No feasibility studies are known at this time, but there is rather only a vision about a certain type of project that should be developed. In most cases, it is very difficult to identify this milestone

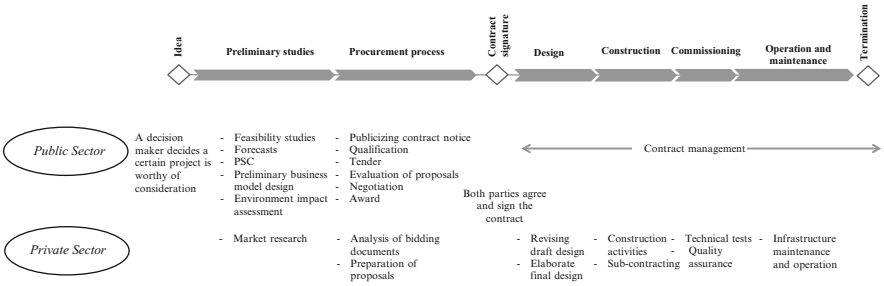

Fig. 1.3 Public versus private responsibilities in a PPP project life-cycle perspective

because it is not rare for this first idea to occur during the previous generation, particularly when thinking about very large projects.

After the original idea, the "creators" usually lobby for the project until the decision-maker responsible for that area formally decides to initiate the first phase of the process: preliminary studies. This phase can also last several years and involves forecasting and technical studies and the first investment estimations, costs and revenues, and it can also include a preliminary business model design and the PSC computation, among other studies. Next, there is the procurement process, which can be subdivided into several stages depending on the procurement model used (e.g., one versus a two or three stage process; with or without qualification; with or without a negotiation phase; invitation only versus open tender; etc.). Figure 1.3 presents a simple example.

The procurement process has the simple purpose of selecting the best possible partner/proposal, after which both agents engage in a relationship through the contract signature. For a large project, it might take several decades from the beginning to the time the contract is signed.

After the contract is signed, the winner will start the necessary procedures to construct the infrastructure, generally involving a phase where a more detailed design is required, followed by the construction itself. Following the construction, there is generally a short period of commissioning (in roads, it is very short, but in airports, it can take more than 1 year), where technical verifications and quality assurance processes are developed to ensure that the infrastructure and/or the service will behave properly. Once these processes are finished, the operation itself begins, with the necessary maintenance activities. The process ends with contract termination. Because the contract is signed until its termination, the main role of the public sector is contract management, further discussed in Chap. 4.

1.9 The Concept of Risk and Risk-Sharing

1.9.1 Risk and Uncertainty

Most activities involve risks. Any organization or project, at different levels and with distinct natures, needs to address several risks. This is the main reason why risk management is an area of increasing academic and professional interest. Risk and uncertainty are concepts frequently used interchangeably. However, they are not exactly the same. Uncertainty is an intrinsic characteristic of systems. There are changes in nature and in the economic and social contexts that are not predictable. Who can make accurate assumptions on the levels of fuel consumption in the next 10 years? How will interest rates behave in the next year? Experts might have reasonable ideas and provide some solutions, but there is always a high degree of uncertainty.

This uncertainty might turn into risks. Those agents directly affected by a specific uncertainty represent a risk. For a fuel producer, the uncertainty about the evolution of the tablet market (small personal devices) does not represent a serious risk. In contrast, the uncertainty behind the consumption of fuel represents an important risk that will have a direct impact on companies' performances, for example, on waste collection companies. For that risk, the company needs to protect itself by, for example, reducing costs or increasing financial robustness.

1.9.2 Risk Classification

Different authors present distinct classifications for uncertainty. For example, Lessard and Miller (2001) distinguish several types of uncertainty based on the source:

- Natural: geology or weather;
- Market: interest rates, risk premiums, and exchange rates, among others;
- Country/fiscal: regulatory environment, contract enforcement, legal and political stability or terrorism, to name a few;
- Industry/competitive: demand and competition; and
- Technical/project: construction and project management.

Marques and Berg (2011a) propose a categorization of risk particularly useful for PPP projects through a three-category model: production risk, commercial risk and context risk. Each consists of the following:

- Production risk: planning, design, expropriation, construction, environmental, maintenance and major repairs, operation, technological and performance;
- Commercial: demand, collection, capacity and competition; and
- Context: financing, inflation, legal, regulation, unilateral changes, public contestation and *force majeure*.

In the liberalized private market, agents have the ability to change their actions to address new challenges. If consumption decreases, production needs to slow

down. Infrastructure PPPs are a peculiar case because these, in general, are not provided in a liberalized market.

As argued before, to avoid all problems with contract incompleteness, the managerial flexibility of the concessionaire is reduced. The excessive constraints placed in the contract limit the private sector's ability to change actions. Furthermore, the administrative process to address contractual changes – renegotiations – is time and cost consuming and is not compatible with commercially pro-active management.

Moses (2004) claims that large scale systems are particularly vulnerable to uncertainty because of what the author defines as "ilities": flexibility, sustainability, durability, reliability, scalability, safety and robustness.

1.9.3 Risk in International Standards

The ISO 31000, the international standard for risk management, defines risk as the "effect of uncertainty on objectives". For this definition, "effect" is any deviation from an expected value, and objectives can have different natures (economic, financial, environmental and social) and can be developed at different levels of the organization and/or project (strategic, tactical and operational).

The risk is associated with the consequence of an event and its likelihood. The impact of a large-scale asteroid colliding with Earth would be enormous, but the probability that this will happen is extremely low. Therefore, this is not an important risk to account for in organizations and projects. Certainly, a world financial crisis has a lower impact, at least from a human survival perspective. However, the probability of occurrence is higher, and this is a risk worth mitigating.

1.9.4 Risk Assessment

Ignoring risk is not an option. Agents need to be prepared and to develop the proper solutions to address risk, with risk assessment being the first step. Risk assessment, as defined by international standards, requires three distinct stages: risk identification, risk analysis and risk evaluation.

1.9.4.1 Risk Identification

Risk identification is a crucial and complex step. It involves the identification of all risks affecting the project, irrespective of whether they are, or not, controllable. The key objective of this task is to provide a comprehensive list of any event that could affect the objectives of the project.

1.9.4.2 Risk Analysis

Risk analysis is about understating the nature of each risk. To evaluate risk (next step), it is necessary to know the consequences of the potential risks, the impact on the project and the likelihood that the risks will take place. This can be a difficult

task because many times there are not enough quantitative data about certain risks. The more complex and unique the project, the more difficult the task becomes. To overcome the lack of historical data, it is possible to benchmark similar projects and try to adapt past experience to the project. The lack of historical data to assess risks will be discussed in Chap. 2.

1.9.4.3 Risk Evaluation

Risk evaluation is the third and last step in risk assessment. It involves looking at each risk and its consequences and likelihood and determines whether the risk should be accounted for in the project. This implies defining risk criteria, knowing which risk requires particular attention and, possibly, mitigation measures.

1.9.4.4 Risk Treatment

After the assessment of the risks, it may be necessary to develop treatment measures to address some risks. There is a wide range of options to cope with risks, ranging from a simple solution (contracting an insurance policy) to more complex alternatives (changing the contract structure). Of course, many risks are not insurable, for example, demand risk, and require more complex approaches. Chapter 3 will be dedicated to this issue, using the concept of flexibility and flexible contracts to address the most relevant risks.

Risk is the core of renegotiation. In a perfect world, where risk would not exist, meaning that there would be no uncertainty and all expected values would be confirmed, there would be no need for renegotiation. Renegotiation happens because of risks. In fact, renegotiations are the proof that risks are real. When some risks become real, there is the need to readapt the contract to the new event, leading to the renegotiation of the contract. Chapter 5 will analyze the literature on renegotiations and experiences in some countries and will define and discuss sound practices and measures to avoid them or to address them.

1.10 World Trend of PPP Arrangements

Since the early 1990s, PPP arrangements have had a tendency for growth. Nevertheless, with the 2008 financial crisis and the subsequent Euro crisis, PPP transactions have decreased in Europe on average, but they have increased in other continents (mostly in Asia). Figure 1.4 presents the European PPP market figures for the period 2003–2011. In 2011, according to the European Expertise PPP Centre, the value of PPP transactions was approximately 17.9 billion Euros in a total of 84 projects not including the local PPP projects. This represents an average project value of 213 million Euros.

Notwithstanding the impact of the financial crisis on the PPP market, the long term trend has been an increase in the use of this procurement model not just at the national level but also at the regional and local levels.

In recent years, growth in the use of PPP has been observed in countries across South American, Africa and Asia, where the levels of infrastructure are relatively

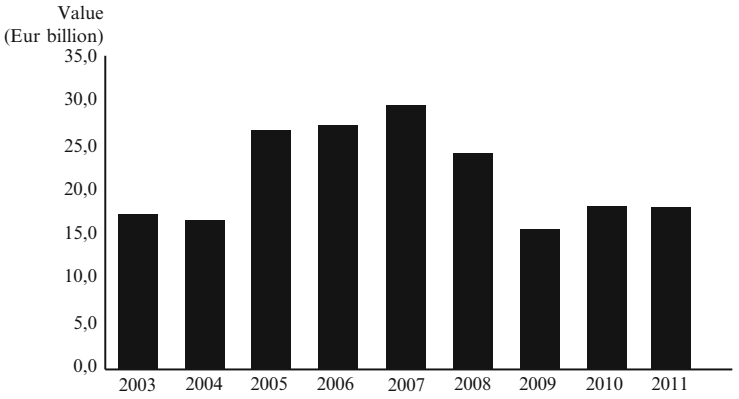

Fig. 1.4 European PPP market (Source: European Expertise PPP Centre; Units: billion Euros)

low compared with those in Europe or North America. For example, in Brazil, a series of large PPP projects are underway in the airport sector, the high-speed rail sector and the environmental sector. The same trend is happening in many African countries with the support of the World Bank (WB) and the African Development Bank (ADB), which have demonstrated their preference for the PPP model. In Asia, India and China are particularly active in using this procurement scheme.

More recently, in the Middle East, there has also been a trend toward engaging the public and private sector in public service provision. This can be explained by the possibility of these countries having access to the expertise and know-how of international firms with large experience, which, under traditional procurement techniques, would not be possible.

Public Sector Comparator

2

2.1 Introduction

Several academic and empirical studies have been devoted to studying the main benefits and pitfalls of PPP models. They have been identified in Chapter 1, and regardless of the extraordinary contributions made toward understanding the consequences of using this procurement model, it is of the utmost relevance to develop a "bird's eye" perspective and look at the first moment when a PPP model was considered. Many problems with PPP utilization are related to the fact that some projects should not be developed under this model in the first place.

The literature provides several classifications for PPP (Allen 2001; Bennett and Iossa 2006; Meda 2007; Cheung et al. 2010; Marques and Berg 2011a), but as mentioned earlier, PPPs are essentially a procurement model for which there is always one alternative – traditional procurement. Governments should be focused on the final output (the public service) and the conditions under which it is provided (quality levels).

PPPs or traditional procurement arrangements are possible alternatives to provide that same output. Because decision makers have different models to ensure the provision of the infrastructure and/or service, it is necessary to compare both models and select the best one. This comparison can be made using qualitative or quantitative methodologies. To avoid the subjectivity of qualitative assessment, practitioners have developed a quantitative tool for their projects: the PSC. Although the PSC is not immune to criticism, it allows (at least partially) the subjectivity of the qualitative analysis to be addressed.

This chapter will analyze the concepts of PSC and VfM and will also provide an overview of the different alternatives for PSC calculation. The analysis will focus on its main strengths and weaknesses. The analysis also includes an international benchmark that looks at the calculation methods adopted by governmental agencies, particularly the discount rate.

Finally, this chapter will also present and discuss some real case studies to illustrate the different calculation methodologies and will perform a critical

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assessment of each country's experience. Later on, it will illuminate the problem of uncertainty in a PSC calculation, shifting the process from a deterministic to a probabilistic source.

2.2 PSC Definition

The PSC is a theoretical calculation of the total costs for the public sector of developing and operating an infrastructure and/or service. It is basically the sum of cash-flows (including CAPEX and OPEX) for a pre-determined duration, incorporating the efficiency gains arising from the manager learning curve and the retained risk, assuming a public management model. However, there are some distinct approaches to the definition of the PSC. Quiggin (2004) defines the PSC as a single number, while Grimsey and Lewis (2005) prefer a more holistic definition of the PSC, which considers the entire process of decision making.

Considering the existing academic literature and technical reports, the authors summarize in Table 2.1 the main definitions of the PSC. The academic literature dealing with the PSC is still limited, with some exceptions (Heald 2003; Bain 2010; Hui et al. 2010; Cruz and Marques 2012a, 2013a) based on technical reports.

In this book, we adopted the first definition, under which the PSC can be interpreted as an extrapolation of the concept of life-cycle cost analysis (LCCA).[1] While LCCA only accounts for costs, the PSC also addresses revenues, either direct or indirect. Direct revenues are those arising from user charges (tariffs, tolls, etc.), while indirect revenues are related to third party revenues (sales of terrain, rentals, advertising, etc.).

There are several objectives behind PSC calculation. The main objective is to demonstrate VfM, i.e., allow an economically rational choice between PPP schemes and traditional procurement. While doing that, PSC calculation allows the project promoter to focus on the output specification and also on the risk allocation for the project (Partnerships Victoria 2001). The calculation of the PSC allows for simulating different risk allocations and selecting the one with the higher VfM.

The immediate purpose of the PSC is to provide a tool for the decision making process of the procurement model. However, before that, the type of knowledge and expertise that the public sector can acquire when assessing all costs and revenues, from a life-cycle perspective of the project, and exhaustively identifying the main sources of risk is extremely valuable in assessing the business model, the type of contract and the optimal risk sharing agreement.

[1] LCCA accounts for all costs, recurring and non-recurring, for the entire life-cycle of the infrastructure. These include all expenditures related to owning, financing, operating, maintaining and, if the case should arise, disposing the infrastructure and/or service (US Department of Commerce 1995; Sarma and Adeli 2002; Cruz and Marques 2012b).

Table 2.1 Literature review on PSC definition

Author	Proposed PSC definition
Netherlands Ministry of Finance (2002)	The Public Private Comparator (PPC) and the PSC are the first instruments which provide insight into the possible added value of a PPP procurement by comparing the PPP procurement option with the public approach. Furthermore, the PSC gives us an idea of the total projects costs over the project life-cycle
Industry Canada (2003)	PSC as a hypothetical, risk-adjusted costing by the public sector as a supplier, to an output specification produced as part of a procurement exercise
Quiggin (2004)	The idea of the PSC is to estimate the costs of delivering a given service through the public sector. Financing under the private finance initiative (PFI) is approved if and only if the cost of service is less than that of the PSC
Grimsey and Lewis (2005)	Rather, the possibility of achieving extra VfM by implementing a PPP can be estimated (under the approach in the UK and some other countries) with a twofold analysis conducted prior to the PPP implementation. It comprises, first, the calculation of the benchmark cost of providing the specified service under traditional procurement and, second, a comparison of this benchmark cost with the cost of providing the specified service under a PPP scheme. This benchmark is known as the PSC
Australian Constructors Association (2005)	A PSC is an estimate prepared for the Government on what it would cost to meet the performance specification for a PPP in the public sector, using traditional delivery methods and taking proper account of risk
Infrastructure Ontario (2007)	Estimated total costs (including adjustments for retained risks and ancillary costs) to the public sector of delivering an infrastructure project using traditional procurement processes
Morallos and Amekudzi (2008)	The PSC estimates the expected life-cycle costs to the public agency, if the project was pursued through a traditional procurement. It uses a discount cash-flow (DCF) analysis to provide a projection of the NPV of expected cash-flows
Ghavamifar (2009)	The PSC is a benchmark used to determine whether the private proposals offer better VfM to the public sector
Bain (2010)	A PSC represents the hypothetical, risk-adjusted cost of a project – such as a road scheme – when that project is financed, owned and implemented by the government. A PSC is commonly used in public procurement decision making as a yardstick against which private investment proposals are evaluated
Hui et al. (2010)	PSC is a benchmark cost that estimates the quality of services, price, time frame, risk apportionment and certainty of a publicly financed project to deliver equivalent benefits to the PPP option
Shugart (2010)	The basic idea is that it is important to demonstrate quantitatively that the PPP project is superior to an alternative public sector project that would deliver the same (or very similar) services. This hypothetical public sector project is often referred to as the PSC

Source: Adapted Cruz and Marques (2012a)

There is no other phase in a project development chain where the public sector develops such an insightful knowledge of the project/business main determinants, such as in the PSC calculation phase.

2.3 Problems with PSC Calculation

2.3.1 Decision Narrowed to a Single Number

The main problem with the PSC is that it narrows the decision making process to the comparison between two numbers: the PSC and the PPP.[2] The PSC is a theoretical calculation including long-term forecasts and is therefore highly vulnerable to errors. In fact, the difference between the PSC and the PPP values is often smaller than the error margin in the calculation of the PSC.

Many PSC critics have claimed that the decision between PPP and PSC is too important to be made on a simple comparison between two numbers. In fact, irrespective of the process complexity, particularly the calculation of the PSC, or of the political objectives that the government might have to develop PPP schemes, the final decision comes down to a simple comparison if one number is higher than the other.

2.3.2 Lack of Transparency

The PSC if often criticized because of its lack of transparency. As Bain (2010) claims, the PSC is often a "black box" without any scrutiny. This opaque process raises suspicion, particularly considering that it will support the decision making process of projects worth multi-millions of Euros.

CBA also suffers from this same problem. Some countries, e.g., the UK, have developed a short summary of the CBA to support a participatory environment and increase public scrutiny. This might be applied to the PSC because most technical reports are extremely complex.

2.3.3 Lack of Robustness

Heald (2003) affirms that "Even disinterested policy analysts, operating with different assumptive worlds about public versus private performance, are likely to generate different numerical answers." When the decision is narrowed to a single number, the lack of robustness might jeopardize the final decision. This lack of robustness is difficult to overcome because the assumptions made in the beginning

[2] This number corresponds to the value proposed by the private sector to deliver the infrastructure or manage the service.

have an enormous impact on the final result. Just to give an example, it is not rare that a 1 % change in the discount rate will influence the final PSC by 7–10 %.

Heald also claims that the responsible parties for the PSC are not "neutral" but are "interested players". In fact, consultants or public servants actively involved in the PPP programs often perform these calculations, and therefore, they are interested in the development of these projects. One might establish a parallelism with the optimism bias that takes place in most traffic forecasts in highways or consumption estimates in drinking water projects.

Pollock et al. (2002) mentions that the project samples used to estimate the costs and time are often small and/or unrepresentative. Therefore, the PSC number is often estimated using little credible data.

2.3.4 Lack of Data

PSC calculation is strongly based on using historical data to estimate future costs. This raises a number of problems:

(i) If a project is entirely new, then there is no historical data (e.g., constructing a nuclear power plant in a country with no such infrastructure);
(ii) The data may not be appropriate; this might happen when the projects are not entirely comparable for several reasons: the legal and fiscal framework changed significantly with strong impacts on the final cost accounting, special features among past projects, etc.;
(iii) Historical data can also result in a lack of rigor because teams do not know how those values were calculated or if the owners accounted for cost escalations;
(iv) There are no accounting standards to ensure data consistency and the comparability of projects; and
(v) The pattern of quality of service changes considerably over time and it is difficult to measure.

2.3.5 Difficulty in Estimating Efficiency Gains

The calculation of the PSC should account for future efficiency gains. In a time period of 20 or 30 years, it is reasonable to expect an improvement in the public sector managerial capacity. This component of efficiency gains corresponds to the improvement in the project performance that one should expect over time because of the accumulated know-how of the public sector. For example, considering a hospital managed directly by the public sector, it is very likely that over the next 20 or 30 years, the efficiency levels will increase. This scenario of efficiency gains over time is very difficult to determine.

This difficulty arises at two different levels. One is related to the identification of the efficiency gains in the present based on the current levels of the efficiency of the benchmarking sample. Naturally, this requires comparability between the samples

(avoid comparing 'apples' with 'oranges'), which is not always possible. The other is related to the forecast of future efficiency or productive gains, and here, the complexity is much higher. The situation is even more serious when the market structure is not well consolidated and when it is expected that strong reforms take place in that period (e.g., allowing for earnings of economies of scale and economies of scope).

2.4 VfM

The concept of VfM is directly related to the efficiency and effectiveness of PPP projects (Heald 2003). The same author argues that even though this instrument is clearly technical and developed within public auditing, it is not far from the political area and decision theory (see more in Schoemaker 1982; Anand 1993).

In fact, the VfM is about measuring the utility of the expenditure, or searching for the public procurement solution with the highest efficiency. The UK Audit Commission defines VfM as a way of "obtaining the maximum benefit with the resources available". In this context, this is particularly relevant because resources, or expenditures, are taxpayers' money and are therefore subjected to higher uncertainty and transparency.

Going back to Heald's (2003) concepts of efficiency and effectiveness, one can argue that both alternatives provide the same output. Whether developed under public management or through a PPP arrangement, the project will deliver the same pre-determined outputs. These outputs are defined a priori by the government and incorporate not only the service characteristics (provided in an efficient way) but also the quality standards that should be met.

Therefore, if both alternatives are equally effective, the VfM is about efficiency. To produce the specified outputs, the alternatives consume different inputs. This process is illustrated in Fig. 2.1 which presents the production functions of two alternative procurement models: *Alt 1* and *Alt 2*.

As mentioned, the project specifications will define the service level *O'*. For that level of service, the purpose of the VfM test is to calculate the inputs used, I_{Alt1} and I_{Alt2}. In the example presented in the figure, $I_{Alt\ 1} < I_{Alt\ 2}$, and therefore, *Alt 1* should be adopted.

In practical terms, the difference can be measured by the amount of expenditure required by the concessionaire or the rents paid to the grantor. Note that this is different from simply choosing the cheapest solution.

Some projects work on a *stand-alone* basis, meaning that the revenues generated by the project (tariffs paid by users) are enough to cope with the CAPEX and the OPEX. Other projects require governmental subsidies to ensure the economic equilibrium of the project. It is common for transportation projects, hospitals and prisons to fall within this category.

Figure 2.2 illustrates these two types of projects. The grantor has a negative cash flow with Project A requiring subsidies and has a positive cash-flow with Project B working on a stand-alone basis and paying a rent.

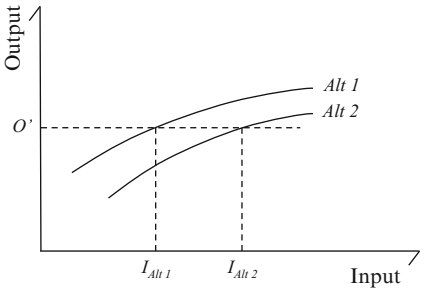

Fig. 2.1 Efficiency of the alternative procurement models

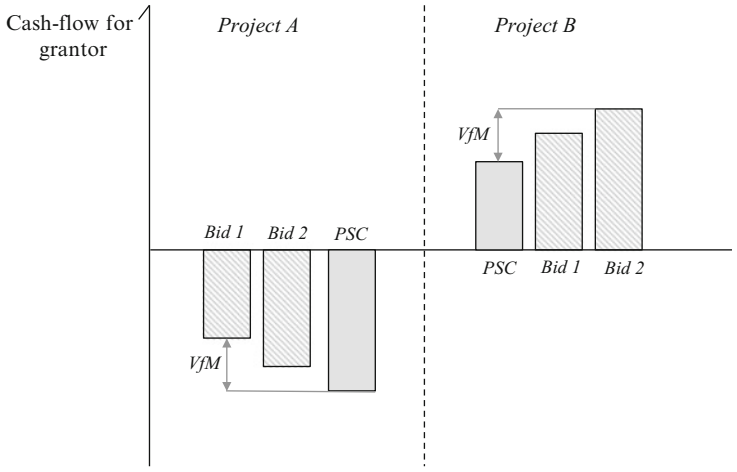

Fig. 2.2 Projects with alternative cash-flows

In both these theoretical cases, the PPP scheme is the option with the highest VfM. In Project A, the best solution is the cheapest (Bid 1), while in Project B, the best solution is the one maximizing the grantor's revenue (Bid 2). Understanding the category (and the cash-flow value) in which the projects falls is crucial and will influence the criteria adopted for selecting the most advantageous proposal.

2.5 PSC Structure

The PSC is a valuation of the life-cycle costs of the project, but it also accounts for risks. Countries such as Australia and Canada follow a structure for the PSC divided into several components.

Figure 2.3 presents a typical PSC structure developed in the UK, Canada and Australia. The first component, raw PSC, corresponds to the baseline cost, accounting for all life-cycle costs of the infrastructure and/or service, deducted from the

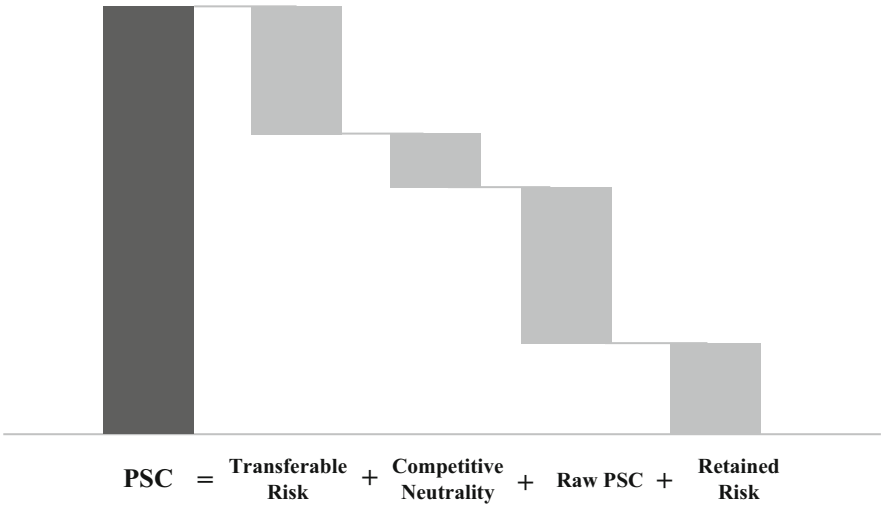

Fig. 2.3 PSC structure

expected revenues. The cash-flow is then discounted, and the sum of all cash-flow for the entire duration represents the raw PSC.

Competitive neutrality intends to correct the PSC for biases arising from public ownership and management. In many countries, public owned companies are exempt from some types of taxes, construction permits or environmental permits. This component corrects the PSC for the potential benefits of such a status.

Transferable risks are those risks that fall under the private sector responsibility in the PPP model. This might include construction, availability or demand, among others. Finally, retained risks are those risks that even in the PPP model are managed by the public sector.

2.6 International Benchmarking

2.6.1 Overview

Most of the countries that have been developing PPP projects have adopted some form of the PSC, for example, Australia, Canada, Portugal, Republic of Ireland, South Africa, the Netherlands, the UK and the United States. The UK, Canada and Australia have inspired and influenced other countries' methodologies. The level of maturity in PSC calculation is very different across countries. These three countries have a much more detailed approach, and the process is guided by several technical reports containing recommendations and decreasing the subjectivity of the teams responsible for PSC calculation. The next subsections will look into the different methodologies used by these countries not only in PSC calculation (cost estimations and discount rate) but also in how the process is managed and when the PSC is used.

2.6.2 Australia

In the Australian state of Victoria, the PSC is calculated (by Partnerships Victoria) before the bidding process through the so-called preliminary PSC. This early and detailed calculation improves as the process goes forward. As in the UK, the Australian PSC is composed of the four typical components: transferable risk, competitive neutrality, raw PSC and retained risk.

The discount rate in Victoria followed a path similar to the UK. Until 2003, there was a 6 % discount rate, which dropped to 3.5 % in that year. However, unlike the UK, in Partnerships Victoria, it was possible to find different discount rates for the PSC and for the PPP bids because of systematic risks (the difference between the rates does not take into account for unsystematic risks).[3] Unsystematic risks were incorporated in the transferable and retained components.

To allow for project risk classification, the Treasury defined three groups according to the level of risk. The asset beta for the capital asset pricing model (CAPM) calculation varies from 0.3 (to the less risky) up to 0.9 (to the more risky). The risk free rate is assumed to be the yield of the Commonwealth Bonds (10-year maturity period).

Partnerships Victoria addresses an important issue: the discounting of negative cash-flow. If, for a certain year, the costs exceed the revenues, generating a negative cash-flow (not rare in PPP projects) means depreciating a cost. In real cases, negative cash-flow tend to happen in the first years, when the discounting is not so significant, and because of construction costs. In the late years of the contract, when discounting is substantial, cash-flow are generally positive, mitigating this problem.

2.6.3 Canada

The Canadian guidelines for PSC calculation were established in 2003 (as in the UK and Australia). The technical guidelines establish six stages (Industry Canada 2003):

1. Construction of the risk matrix;
2. Identification of the specific risks;
3. Quantification/calculation of the consequences of the risks;
4. Estimation of the probability of the risks;
5. Valuation of the cost of the risks;
6. Allocation of the risks.

[3] Systematic risks are those not controlled by the agents (e.g., market risk), while unsystematic risks can be mitigated (e.g., production risk).

The PSC should be calculated before the bids are presented and upgraded after the bids are delivered. In addition to providing a VfM test, the PSC in Canada is also used to fine-tune the risk-sharing agreement before the contract is formally signed. This is an interesting use of the PSC – simulating alternative contractual arrangements – and a sign of the usefulness of this calculation.

There are several government levels at which PPP projects are developed (federal, provincial and local), and each level is autonomous in deciding when and how to develop these projects. There are no binding methodologies or rules regarding PSC calculation because the typology of projects is so diverse that a "one size fits all" approach is not recommended. Nevertheless, the general guidelines are wide enough to be applied, with adaptations, to each individual project.

The guidelines also address the issue of in-house bidding.[4] No restrictions are made, except that no member of the bidding team should be involved in PSC calculation because he would have access to privileged information, biasing the rules of the game. The guidelines also address the issue of unsolicited proposals, highlighting the importance of calculating the PSC in these cases.

The discount rate used should be the one arising from the weighted average cost of capital (WACC) of the private sector.

2.6.4 Portugal

In Portugal, there are no formal guidelines for PSC calculation. The teams responsible for assembling the PSC for each project can adopt whatever structure and methodology they intend. Naturally, this brings an undesired ambiguity to the process.

Nevertheless, PSC calculation has been mandatory by law since 2003, and to be exempt from the calculation, the projects need to have an investment requirement below 25 million Euros and a total financial burden below 10 million Euros.

The discount rate used in Portugal is fixed by legislation and results from two separate components, the inflation rate and the real nominal discount, which are combined using the Fisher equation:

$$Nominal\ Discount\ Rate = [(1 + real\ discount\ rate) \times (1 + inflation\ rate)] - 1$$

The real nominal discount rate was determined in 2003 by the Ministry of Finance at 4.0 %. It is mandatory according to Portuguese legislation that the bids cannot exceed the PSC value. If this happens, the bidder of the tender should be excluded.

In Portugal's experience with the PSC, it is possible to find cases that follow the typical UK structure for the PSC (light rail of Porto), while others simply calculate the total PSC without accounting for risks (Health PPPs).

[4] In-house biddings are bids presented by public agencies.

2.6.5 Republic of Ireland

In 2003, Ireland approved specific legislation and a policy framework for PPP development, creating a special public body under the designation of "Central PPP unit" and dependent on the Ministry of Finance. The rationale for PSC calculation is no different from other countries, namely it is calculated under the premise of affordability with the intent of delivering VfM through optimal risk allocation.

Four tests are foreseen: before the bid delivery, (*i*) a qualitative VfM assessment and (*ii*) a quantitative assessment, and after the bid is delivered, (*iii*) VfM tests and (*iv*) a VfM test before the final closure to allow contract changes. Although the essence is the same, Ireland calls it the "public sector benchmark" (PSB), which is compared against the NPV of the life-cycle PPP costs. One important difference from Ireland case-study is that third-party incomes, for example, taxes, are also included.

Ireland divides the risk into three categories: transferable, retained, or shared risks. Risk adjustment is based on changes to the risk transfer structure that affect VfM calculations. Nevertheless, no specific information is set regarding PSC or VfM tests. According to the Irish Department of Finance, all methodologies and technical issues should follow the UK approach and the HM Treasury technical notes, respectively.

The Central PPP Unit guidelines for selecting the appropriate discount rate states that this should be based on the yield of the Government Bond (choosing the most adequate maturity period according to the project's lifespan). Government bonds typically have the following maturity periods: 3 and 6 months and 1, 3 and 10 years.

Although large infrastructure such as roads, dams or hospitals might have lifespans over 30 years, the longest bond is 10 years. This means that the bond is based on the risk-free cost of debt. Risk factors are taken into account in the cash flow estimation and not in the discount rate itself. However, the effect is ultimately the same. Conceptually, it is an entirely different approach from the UK.

The same discount rate should be applied to the PSB and PPP. Qualitative assessments are also allowed, and for the final decision, the VfM test is not enough. Affordability is also a necessary condition when considering the PPP model.

2.6.6 South Africa

In South Africa, the unit responsible for PPP development, management and monitoring is the "South Africa National Treasury PPP Unit". The development of VfM tests is mandatory before bids are presented. As in Ireland, two models should be built. A PSC reference model should include all capital and operating costs (base PSC) and adjust all associated and identified risks. Another model should be used by the private sector and should include the hypothetical costs of private sector delivery and also recommend affordability tests to be made.

The PPP Manual (National Treasury 2004) recommends the discount rate be the same as the risk-adjusted cost of capital to the government. This is different from the risk-free rate, which usually adopts a bond yield with an adequate mature period according to the project's duration. The difference is that the PPP Manual incorporates opportunity costs in the risk-adjusted cost and also the economic implications of capital deviation from private consumption to public consumption. This methodology does not take into account for the internal risks of the project itself. These should be corrected in the cash-flow over the duration of the project. If it is not possible to quantify the costs associated with the risks, then a risk premium can be added to the discount rate. Acknowledging the difficulties in dealing with risks as cash-flow, the alternative of adjusting the discount rate could be used. Both the PSC and PPP must use the same discount rate.

2.6.7 The Netherlands

In the Netherlands, VfM tests are thorough because in addition to the PSC, they also include the so-called public private comparator (PPC). The concept of the PPC is the same as the PSC but is used for private bids at an early stage of the process to evaluate whether the PPP model is a good alternative. At this point, without any bids presented, the PPC is used as a benchmark against the PSC. In fact, both numbers are theoretical, and the accuracy of such a comparison is not substantial.

The purpose of such an early stage assessment is to avoid engaging in complex bid procedures that may not provide VfM, thus avoiding the transaction costs.

Other countries also perform this assessment but in a qualitative way. These qualitative methodologies intend to identify whether the project features are suitable to the PPP model. The assessment is made through a quantitative methodology – the PPC.

There is a commissioning authority that has to ensure that the final bids provide VfM when compared with the PSC. If this condition is not met, the process has to be terminated.

PSC calculation is also segmented in components, which are different from the UK categorization. The components are categorized into crude PSC, risks and supplementary financial considerations. The crude PSC is the equivalent of the designated "raw PSC", but the risks are bundled together and not divided into retained, transferred or shared risks.

In 2002, a revised technical report on PSC calculation was published, replacing the initial technical note released in 1999. A second manual was released along with the PSC manual, specifically for calculating the PPC. The guidelines also present a structure for risk evaluation. Three steps define such a structure:

1. Determine the risks;
2. Value the pure risks (risks occurring in one of the project phases);
3. Value the spread risks.

Spread risks are divided into technical (related directly to the project) and market (related to the macroeconomic scenario) risks.

2.6.8 United Kingdom

The UK has vast experience in VfM tests. Nevertheless, before any VfM tests are performed, affordability[5] has to be demonstrated. If and only if the affordability criterion is met, then it is possible to proceed with the selection of the best infrastructure provision model.

The UK guidelines comprise a three-stage approach for assessing the VfM of the PFI (HM Treasury 2006). These stages are sequential over time, and the focus progressively shifts from a strategic perspective to more in depth studies.

Figure 2.4 summarizes the UK approach, which is based on a three level assessment.

The first level (Program Level Assessment) corresponds to a high level approach, with the purpose of identifying whether the project is adequate according to the PFI model. In the second level (Project Level Assessment), the outline business case (OBC) is drawn. This is the first draft of the economic and financial model containing the project cash-flow estimation. Finally, the third stage is developed during the procurement phase to ensure that the assumptions initially made are still valid. These levels are sequential over time.

This three-stage process essentially uses quantitative techniques, particularly the PSC. However, a qualitative assessment can also be considered: viability – analyzing how a PFI can capture the service requirements and the efficiency, accountability or equity issues that may require a direct provision from the government; desirability – analyzing the advantages and disadvantages of developing a PFI, particularly regarding incentives and risk transfer; and achievability – verification of the market interest in such a project but also whether the public sector has enough capacity to develop and manage the PFI (Morallos and Amekudzi 2008).

The UK Treasury, in 2003, established more formal rules to overcome some of the gaps of PSC calculation (as identified earlier). One such rule is the mandatory requirement that both the PFI and PSC should be discounted at the same rate. The incorporation of risk is made through a separate cash-flow over the project duration (retained, transferred and shared risks).

The discount rate was 6 %, which is greater than the risk-free rate (interest rate paid on British Bonds, also called gilts). The rate was closer to the real discount rate used by the private sector for low risk projects. This rate was lowered in 2003 to 3.5 %. The 6 % was too high because risks were already calculated in the PSC and favored the PFI option.

[5] Affordability is understood as the government's ability to keep its responsibilities without jeopardizing the economic sustainability of the system.

Program Level Assessment	High-level approach to select whether the project features fit the PFI model
Project Level Assessment	Procurement appraisal using the OBC
Procurement Level Assessment	Developed during the entire procurement phase and ensuring that the assumptions made on competitive interest and market capacity are valid

Fig. 2.4 The UK approach

2.6.9 United States of America

The use of the PSC in the USA has been scarce. Florida, Oregon and Virginia have used some form of the PSC (NCSL 2010). For example, in the evaluation of PPPs for toll highways in Texas, the government has used a form of "shadow bids" to estimate the costs of a public sector delivery model. In other states, such as Florida, Maryland, and Washington, CBA and qualitative assessments have been proposed and used.

In 2010, the National Conference of State Legislatures released a toolkit titled "Public-Private Partnerships for Transportation: A Toolkit for Legislators". Although benchmarking experiences and best practices are presented, it does not provide an analytical guideline for PSC calculation or PPP development at the national government level. Nevertheless, regarding discount rates, there is an annual guideline ("Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs") issued by the Office of Management and Budget that should be used to update any future costs or revenues. The guidelines published through Circular A-94 note the need to consider alternative provision methods and to evaluate the cost-effectiveness of these alternatives.

2.7 Case Studies

2.7.1 Reshaping Health Services Project (UK)

The aim of the Reshaping Health Services Project (RHS) in the UK is to deliver a new hospital and redesign the primary and social care services integrated in the NHS (National Health System) Plan, for a total of 1.287 beds and 158.669 m^2.

The project was developed under a PFI scheme for a 40-year period, and the funding was based on bonds. The overall advantage of the PFI model over the PSC was 1.81 %.

The methodology used to calculate the NPV was the DCF analysis. A 6 % discount rate was used, in accordance with the Treasury Green Book. The value added tax (VAT) was excluded from the costs, and the irrecoverable VAT was only considered within an affordability analysis (NHS Trust 2003).

Table 2.2 VfM assessment for the RHS

	PSC NPV 40 years (£ million)	PFI NPV 40 years (£ million)	PSC NPV 66 years (£ million)	PFI NPV 66 years (£ million)
Total estimated costs	3,406.6	3,422.3	3,679.1	3,694.7
Retained risk NPV	106.1	28.3	116.3	38.5
Risk adjusted NPV	3,512.7	3,450.6	3,795.4	3,733.2

Source: NHS Trust (2003)

Table 2.3 Risk matrix for the RHS

Risk category	Public sector	Private sector
Ensure plans are in place and fully consulted upon to provide alternative services before current services close	X	X
Develop protocols to ensure integration makes the most efficient use of hospital beds	X	X
Costs of the scheme are contained within the overall affordability envelope		X
Formulate strategies to manage shared risks		X
Manage relationship with the PFI provider		X
Make capital available to provide alternative facilities for services not being re-provided on the Derby City General Hospital site		X
Make funds available to meet transitional costs incurred during development, via strategic assistance fund	X	X

Source: Adapted NHS Trust (2003)

The risks were calculated as cash-flow over the life-cycle of the infrastructure, and the results are presented in Tables 2.2 and 2.3.

As expected, the NPV of the retained risk in the PSC option is higher than in the PFI because the public sector has to address all project risks, while in the PPP option, some risks are transferred to the private sector.

Risk calculation in the UK is performed under specific guidelines. In this case, it was performed in accordance with the Department of Health's generic economic model, which basically corresponds to identifying and assessing all possible risks. The model also included a sensitivity analysis for some key variables, such as capital cost or life-cycle cost, to determine the robustness of the calculation.

The PSC and PFI were compared for two periods: 40 and 66 years. Table 2.4 summarizes the main results.

Thus, the PSC solution provides a higher VfM, even though the difference is quite small. In fact, one may argue that the implict error in the forecasts is higher than the final observed difference between the PSC and PFI.

Table 2.4 Example of a PSC for a hospital

	Over 40 years (£ million)	Over 66 years (£ million)
PSC	3,512.7	3,795.4
PFI	3,450.6	3,733.2

Source: NHS Trust (2003)

Table 2.5 NPV of the PSC and PPP scheme for the Sea-to-Sky highway project

Description	PSC ($ million)	PPP ($ million)
Capital costs	516.0	208.1
Operations and maintenance costs	107.5	3.2
Rehabilitation costs	36.3	
Risk adjustment	42.9	
Competitive neutrality adjustment	41.3	
Payment to Sea-to-Sky		578.5
Total costs – risk adjusted	**744.0**	**789.8**

Source: Partnerships British Columbia (2005)

2.7.2 Sea-to-Sky Highway (Canada)

The British Columbia Ministry of Transportation decided to improve a 95 km stretch of highway between West Vancouver and Whistler with a maximum budget of 600 million dollars, which was approved in 2003. The main objectives of the project were to improve the safety, reliability and capacity of the existing road while ensuring that the project was completed on time and on budget and minimizing the disruption in traffic flow during construction (Partnerships British Columbia 2005).

The project was developed under a PPP scheme with a 25-year duration, including the design, financing, construction, maintenance and operation of the highway.

The methodology used was the DCF analysis to calculate the NPV. A 7.5 % discount rate was used, which is a significantly higher rate than the one used in the UK. Like in the UK example, the risk was calculated as a cash-flow over the life-cycle of the infrastructure. Table 2.5 presents the PSC calculation, and Table 2.6 shows the project's risk matrix.

In this example, the PSC alternative has a lower NPV than the PPP option. This means that the project should be developed directly by the government. Nevertheless, the government decided that the qualitative benefits of developing a PPP arrangement justified the choice over this option.

The reason given was that there were additional highway improvements provided by the PPP option that were not considered in the PSC, such as 20 km of additional passing lanes, improved lighting, safer intersections, etc. (Partnerships

Table 2.6 Risk matrix for the Sea-to-Sky highway project

Risk category	Public sector	Private sector
Design		X
Construction		X
Environment		X
Operation and maintenance		X
Protests or trespass actions		X
Geotechnical		X
Land acquisition	X	
Force majeure	X	
Legal	X	X
Archaeological		X
Insurance costs		X

Source: Adapted Partnerships British Columbia (2005)

British Columbia 2005). The government argued that the user benefits of such improvements, although difficult to quantify, would justify the PPP schemes.

This is an interesting example for several reasons. First, it highlights that the PSC is an instrument to be taken into account by decision makers, but it does not provide a single answer. Second, it illustrates how difficult the analysis becomes when the objects under consideration are not exactly the same. When the project specifications are alike, a direct comparison of NPVs is sufficient. Otherwise, the comparison is qualitative, subjective and has a high level of uncertainty.

2.7.3 Barwon Water Biosolids Management Project (Australia)

Barwon Water is a regional water corporation providing water and sewerage management to a population of approximately 270,000 over more than 8,000 km^2 (Partnerships Victoria 2007). To cope with this responsibility, Barwon Water operates, among other infrastructure, several sewerage systems and water reclamation plants.

To improve the beneficial use of biosolids while reducing land area requirements, greenhouse gas emissions and truck movements, Barwon Water defined a project including the following (Partnerships Victoria 2007):

- *Sludge receival facilities to receive biosolids from the Black Rock water reclamation plant and from regional water reclamation plants;*
- *Fully enclosed sludge storage;*
- *Dual train Keppel Seghers HARD Pelletizers (Indirect gas fired dryers);*
- *Fully enclosed intermediate storage at the Black Rock site; and*
- *A program to use biosolids in agriculture and/or fuel.*

To develop the project, the government decided to consider the possibility of a PPP arrangement. After considering several alternatives, the authorities decided on a DBFO model with a 20-year duration. The rationale behind this duration is that

Table 2.7 PSC calculation

Description	PSC ($ million)
Capital costs	39.0
Operation and maintenance costs	30.8
Other costs	0.7
Raw PSC	**70.5**
Competitive neutrality adjustment	0.2
Risks	11.5
Total PSC	**82.2**

Source: Partnerships Victoria (2007)

although significant investments are required, it was not reasonable to commit to longer contracts because the technology in this sector can change significantly.

The methodology used to calculate the NPV was the DCF analysis, with a discount rate of 6.50 % and an inflation rate of 2.50 %. The results are presented in Table 2.7.

The risk component in the previous table only concerns the transferred risks. The retained risks are not incorporated in this parcel, but the risk matrix in this case is described in Table 2.8.

Only those risks allocated to the private sector are accounted for in the risk adjustment component. The comparison with the PPP option is illustrated in Table 2.9.

In this case, the cost of the PSC option was 5.6 % higher than the equivalent in the PPP. This means that the PPP offers VfM and therefore should be adopted.

2.7.4 High-Speed Rail Line (Portugal)

The project of the high-speed rail line between Lisbon and Madrid is a ground-breaking project in Portugal because no other high-speed line exists. The project costs have to be estimated without historical data regarding these specific lines. The business model developed for the entire high-speed system in Portugal included several PPP arrangements: five PPP contracts for the infrastructure construction and maintenance, one for energy systems, and one for operating the train services. The five infrastructure PPP projects include two for the Lisbon-Madrid line (two sections of the line) and three for the Lisbon-Porto line.

The PSC presented in this section was calculated for the two infrastructure PPPs of the Lisbon-Madrid line (Tables 2.10).

The capital costs were not included in the PSC because in both the PPP scheme and traditional procurement options, the public sector will ensure most of the

Table 2.8 Risk matrix for the biosolids management project

Risk category		Public sector	Private sector
Planning risks			X
Site risks	Development of site		X
	Site unsuitable for technical solution		X
	Cultural or heritage value	X	
	Native tile	X	
	Pre-existing contamination of site	X	
	Restoration of site		X
Design, construction and commissioning	Design and construction		X
	Commissioning		X
Operational	Asset performance		X
	Compliance with legal requirements		X
	Volume	X	
	Quality	X	
	Odor		X
	Maintenance		X
	Operational		X
	Price energy	X	
	Energy volume		X
Asset	Ownership and maintenance		X
	Decommissioning		X
Market risk	Availability of beneficial use markets		X
Environmental	Environment Protection Agency works approval	X	X
	Contamination of land		X
Legal and political	Changes in law and legislation	X	X
	Tax		X
Force majeure		X	X
Finance	Interest rate		X
	Residual value		X

Source: Adapted Partnerships Victoria (2007)

Table 2.9 PSC and PPP comparison

	PSC	PPP
Description	($ million)	($ million)
NPV	82.2	77.6
Savings	5.6 %	

Source: Partnerships Victoria (2007)

financing of the system through EU funds and government bonds. The PSC took into account several types of risks: construction (cost overruns and delays), maintenance (cost overruns), and financial, and it also made adjustments regarding fiscal

Table 2.10 PSC versus PPP for the HSR

	Value (million Euros)	Difference for the PSC
PSC	1.514	–
PPP	1.217	24.4 %

taxes. The costs had to be estimated using data from conventional lines and from similar international projects.

The PPP arrangement was 24.4 % lower than the expected PSC. This difference is mostly due to the construction risk considered, which may have been over estimated. One of the main reasons for cost overruns in these types of projects is the change in the system's design due to political interference. It does not seem credible that this would happen in this case because environmental permits ensure that there are few stations to allow for changes in the location. At least, this is a risk that is easily mitigated. The PSC developed a sensitivity analysis to determine the level of cost overruns under which the best model would be a traditional procurement. The result was 8.2 %.

2.7.5 Case Study Analysis

The short examples presented illustrate the wide range of possibilities in PSC calculation. The level of risk disaggregation can vary significantly. It can be more or less detailed, and it has to account for the trade-off rigor versus the costs. The more detailed it is, the more accurate is the calculation of the PSC. However, the transaction costs involved also increase, though the lack of data frequently prevents this.

Regarding the discount rates, because different countries have different approaches, one would expect to find different values. However, the differences are not meaningful (between 6 % and 7 %). Nevertheless, as mentioned before, a 1 % difference in the discount rate can significantly affect the results, particularly in cases where the difference between the PSC and the PPP alternative is not high. This is the case of the "Reshaping Health Services" project, where the PFI model presented an advantage of just 1.81 %. The error in the cost estimation and forecasts is much higher than this difference.

This is why in the case of the Sea-to-Sky Highway project, the government decided to go ahead with the PPP alternative, even though it was worse than the PSC by 6.2 %. The argument was that there were benefits not captured by the calculation that would be higher than the difference. Although the PSC is just a number to help with the decision making process, this calculation might be helpful in start discussion about the project.

2.8 Critical Issues in PSC Calculations

2.8.1 Discount Rate

The discount rate is used in financial valuation techniques (e.g., DCF) to calculate the present value of future cash-flow. It accounts for the time value of money because for investors, 1 Euro today is more valuable than 1 Euro in 1 year.

Different agents valuate this concept of time value of money differently. Typically, private investors attribute less "importance" to future cash-flow and therefore discount these values at a higher rate. In contrast, governments tend to give a higher value to future cash-flow and therefore use lower rates. Evidence of this behavior can be observed in financial markets. Under normal conditions, the countries' debts pay lower interest rates than private debts. Governments tend to have a long term perspective on growth and development and represent the entire society. Therefore, they take less risks. Private investors are more concerned with short to medium term returns.

PSC calculation is needed to discount future cash-flow. The literature on investment analysis has provided large discussions on this subject (e.g., Marglin 1963; Miles and Ezzell 1980; Esty 1999). From a public sector perspective, the discount rate used is generally the "risk-free rate", which is the interest rate on long term public debt (bonds).

From a private sector perspective, the interest rate should be the discount rate obtained by the WACC.[6] However, for the purpose of PSC calculation, one of the main questions is whether to use, or not, the same discount rate for the PSC and for PPP bids.

The discount rate is used to accommodate the risk profile of the project. There are two alternatives to incorporate risk in the PSC calculation. One is to add a risk component to the discount rate – the riskier the project, the higher the value. The other alternative is to calculate risk separately as an annual cash-flow. It is then added to cash-flow and discounted with the selected discount rate. Each one of these alternative risks is considered for in a different way.

What model should be preferred? The incorporation of risks as cash slows needs a more elaborate knowledge of these risks. It is necessary to identify all risks and evaluate, quantify and allocate each risk to the respective partner. This exercise increases the level of knowledge about the project and allows the government to be aware of the main sources or risks. This might lead to a more pro-active risk management attitude by decision makers. Conversely, if risk considerations are taken in the discount rate, then the degree of uncertainty is much higher. The risk premium will take into account the project profile, but it will not address (at least accurately) the project specificities.

[6] For more on the WACC, see Miles and Ezzell (1980).

The choice of the discount rate has an enormous influence on the final result. Higher discount rates will favor the PPP option. This has to do with the cash-flow profile (Fig. 2.5).

Under the PPP arrangement, most payments from the public sector to the concessionaire are made in the medium to long term. When using a high discount rate, those future payments will be devaluated, thus making the option look "cheaper". Under traditional procurement methods, a large majority of the expenditure is made in the first years (during construction). Under DCF, those payments made initially are less devaluated than those occurring in the distant future.

2.8.2 Cost Estimation

One of the critical tasks in PSC calculation is cost estimation. Because many, if not most, PPP projects have a large investment component, and considering that construction risk is one of the main risks in PPP development, the correct estimation of the costs is extremely important.

It is possible to estimate costs using different models with distinct levels of complexity. Table 2.11 presents, in a very succinct way, some of the main cost estimation models, with distinct levels of complexity, accuracy and robustness.

Models have been evolving since the 1970s, when the first parametric models were developed (Kouskoulas and Koehn 1974; Bowen and Edwards 1985), until neural network models were proposed by the latest literature.

The underlying principle of regression analysis is the selection of variables, for which historical data are collected. The values for the dependent variable are calculated based on the statistical relation with the explanatory variables.

Several types of relationships can be assumed a priori between the dependent variable and the explanatory variables. The simplest relationship is the linear regression, and the complexity can increase toward probit and logit models or other estimation models (Skitmore and Thomas 2003; Trost and Oberlender 2003).

In PSC, the dependent variable is usually a cost (construction, operation, maintenance, etc.), while the explanatory variables are related to the characteristics of the infrastructure and/or service. In the case of a road, the explanatory variables can be the length, the percentage of the length in a tunnel or bridge, or the number of lanes. In the case of a hospital, one can consider variables such as the number of beds, the area per bed, the expected case mix index, the type of medical specialties, etc.

A case-based reasoning method solves new problems based on past experience (Kim et al. 2004). These models are organized according to four steps: (i) building a database with past experiences; (ii) inserting a new case into the system and verifying the similarity between the new case and the existing cases in the database; (iii) solving the new case based on the past solution adopted in the most similar old case; and (iv) updating the database with the new case and the respective solution (Perera and Watson 1998; Kim et al. 2004).

Neural networks (NN) are a computer-based system simulating the knowledge-building model of the human brain. Some researchers have used NN to improve

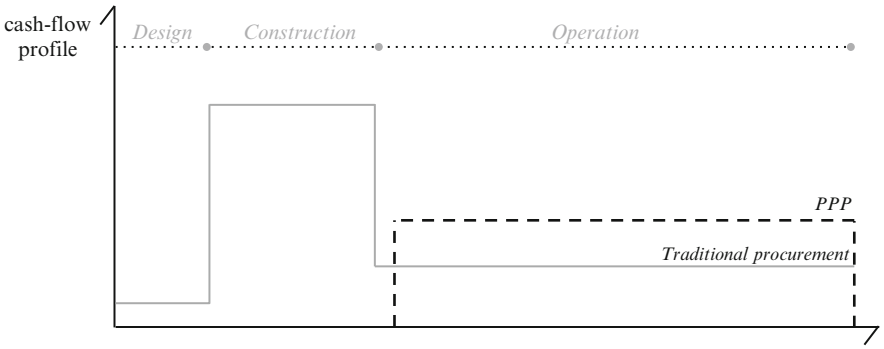

Fig. 2.5 VfM analysis using the PSC

Table 2.11 Comparison of cost prediction models

	Regression	Case-based reasoning	Neural networks
Weight of historical data	Heavily dependent	Heavily dependent	Heavily dependent
Complexity	Simple to use	Complex	Highly complex, even though there is commercial software to compute the model
Accuracy	Poor	Relevant	High
Robustness	Poor	Relevant	Relevant

costs estimations (McKim 1993; Yeh 1998; Boussabaine 1996; Adeli and Karim 1997; Hegazy and Ayed 1998; Tam and Fang 1999; Reuter and Moeller 2010).

The concept behind NN is trying to relate inputs and outputs (in this particular case, costs) through hidden layers and neurons. Determining the number of layers and neurons is basically performed through trial and error. The complexity behind these calculations is a severe drawback for these models, though some commercial software has been developed; for those not familiar with the concept, NN become a "black-box".

Irrespective of the model adopted, cost estimates are heavily dependent on historical data. As mentioned before, this raises several problems related to the absence of data and the lack of consistency across data panels.

The infrastructure sector also faces another problem concerning the accuracy of forecasts in maintenance plans. This sector is known for relatively low quality standards, at least when compared to other industrial areas (automotive, technologies, etc.). Thus, it is more difficult to forecast the exact maintenance needs for the long term based on the greater patterns of the quality.

2.9 Probabilistic Calculation of the PSC

2.9.1 Uncertainty in PSC

It is now clear that a PSC calculation incorporates many sources of uncertainty. Instead of having that uncertainty in the background, it should be made explicit right from the start. This means that instead of a single number, the PSC might be a distribution to accommodate the uncertainty of the calculation, the result of several uncertainties in the cost components.

Currently, the process of determining the VfM of the PPP option is based on the direct comparison of the two numbers (PSC and PPP).

Figures 2.6 and 2.7 represent two theoretical projects with different PSC values and distinct "errors" in each calculation. The direct comparison between the PPP score and the PSC ignores the error inherent to the PSC calculation. Assuming these two examples, it is clear that the degree of confidence when comparing PSC 1 with the best bid is significantly lower than the one in project 2 (PSC 2).

Nevertheless, the decision makers are not always aware of these differences because the uncertainty behind the calculation is rarely made explicit in the decision making process.

Therefore, for each cost component, one should assess the uncertainty, or risk, and the input variable should also be a distribution function instead of a single number, which has an almost null probability of being the real number.

2.9.2 Risk Management for PSC Calculation

The calculation of a probabilistic distribution for the PSC depends on the quantifying risks. As mentioned earlier, these risks are related to construction, operation, financing, etc.

The literature provides several guidelines for risk assessment, but in this book, the authors use the methodology of ISO 31000: Risk management – Principles and guidelines. This international standard defines a three-stage process for risk assessment (Table 2.12): (1) Risk identification; (2) Risk analysis; and (3) Risk evaluation.

Risk assessment is one of the two components of risk management, the second being risk treatment. In the context of PPP, risk treatment is the identification of measures that decrease the impact of risk, either by its probability of occurrence and/or its impact. Regarding this particular issue, Chap. 4 will address flexible mechanisms to cope with risk mitigation.

At this stage, the focus should be on assessing risks to incorporate in the PSC calculation.

Risks should be ranked according to the product of the impact and the likelihood of occurrence. The impact can be estimated using the OBC or by directly quantifying the occurrence of an event.

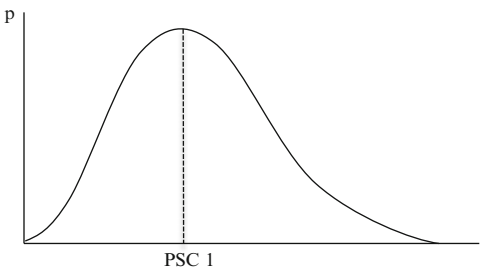

Fig. 2.6 Distribution function of PSC 1

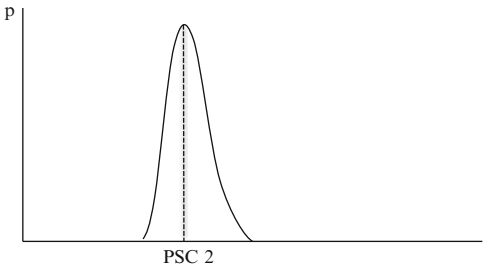

Fig. 2.7 Distribution function of PSC 2

The probability of occurrence is more difficult to estimate, and its calculation is restricted to the use of historical data, predictive techniques (basically, modeling and, in most cases, the use of historical data to calibrate the models) and expert opinion. Over the next sections, these methods will be exploited using a case study. The rationale is to make explicit in the PSC the uncertainty perceived by the agents as risk. Two models will be used: a simpler model – Monte Carlo simulation – and a more complex model – BN.

2.9.3 Probabilistic PSC Calculation: A Case Study

2.9.3.1 Summary of the Case Study

The case study used to illustrate the probabilistic calculation of the PSC is an extension of the example developed by Cruz and Marques (2012a). The PSC is calculated for a Hospital PPP developed under the UK model, i.e., just regarding the infrastructure and ancillary services.

Some hospital PPP projects include clinical management (e.g., Spain and Portugal), but the most used model regards only the construction and maintenance of the infrastructure and ancillary services (e.g., laundry, cleaning and security). The example presented next is a real case developed in Portugal where the model

Table 2.12 The three-stage process for risk assessment

Stage	Description	Methodologies
Risk identification	For each project, all risks should be identified. These risks might be under the control of the stakeholders (e.g., production risk) or it may not be manageable by any of the partners (e.g., demand risk of a highway, which depends mostly on GDP growth and car ownership)	Check-lists, interviews, brainstorming, benchmark, etc.
Risk analysis	Risk analysis encompasses the understanding of risks, particularly their fundamentals (e.g., the causes, consequences, and potential impacts on the final outcome, probability, etc.). The impact and probability of the risk is usually determined by modeling, which can be complex. Simple techniques might include extrapolation, and more advanced techniques can also be used (e.g., artificial intelligence)	Modeling techniques
Risk evaluation	After the risk analysis, it is necessary to evaluate several risks and determine which of them are more critical and require particular attention. This may imply a more sophisticated model to understand the risk, but it also implies the identification of measures to mitigate the risk	Modeling techniques, valuation techniques

began as infrastructure plus clinical services,[7] but because of political reasons, it changed toward the typical UK model.

2.9.3.2 Risk Identification

There are many risks associated with construction and operation that might correspond to each cost component. The exhaustive identification of all cost components is a complex task that frequently involves several officers with different responsibilities for the project. Table 2.13 presents an example of risk identification for a hospital PPP.

2.9.3.3 Risk Analysis and Risk Evaluation

For each risk, it is necessary to identify, whenever possible, the variability of historical data. The modeling of this risk can be conducted by fitting the most likely distribution. These distributions can be different. For example, there is a trend to underestimate construction costs, which is why they often follow a log normal distribution, $C \tilde{} \ln(\mu, \sigma^2)$ (Fig. 2.8).

[7] The Portuguese model was quite unique because the PPP arrangement for the hospital is composed by two different contracts: one for the infrastructure and one for the clinical management, the first with a longer duration than the second, 30 and 10 years, respectively (Cruz and Marques 2013d).

Table 2.13 Example of risk identification for a hospital

Class	Sub-class
Construction	Building construction
	Underground parking
	Exterior works (gardens, access)
	General equipment
	Project design
	Supervision works
Infrastructure maintenance	Maintenance works
Operation	Energy
	Water and wastewater
	Solid waste
	Security
	Cleaning
	Laundry
	Catering
	Sterilization
	Other

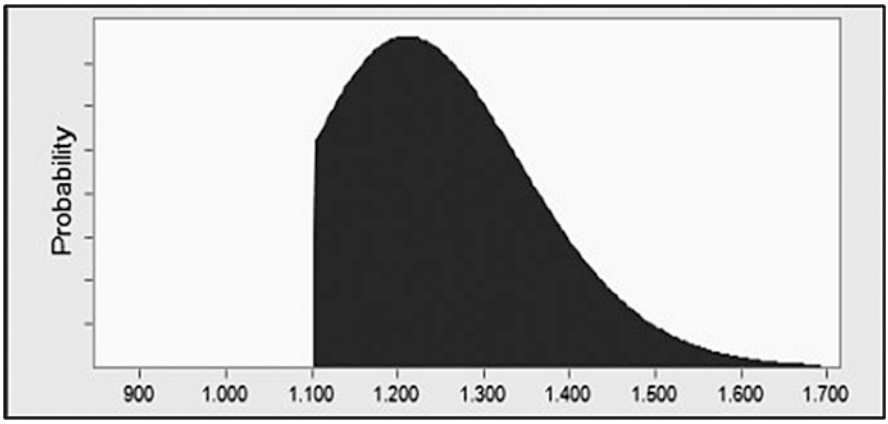

Fig. 2.8 Distribution of the hospital building construction cost per square meter (Source: Cruz and Marques 2012a)

2.9.4 Modeling Risk

2.9.4.1 Alternative 1: Monte Carlo Simulation

The use of a Monte Carlo simulation to quantify uncertainty is one of the most straightforward approaches and has already provided good results.

A set of iterations, usually around thousands, generates random numbers for each one of the inputs following the pre-defined distributions. In the case of the

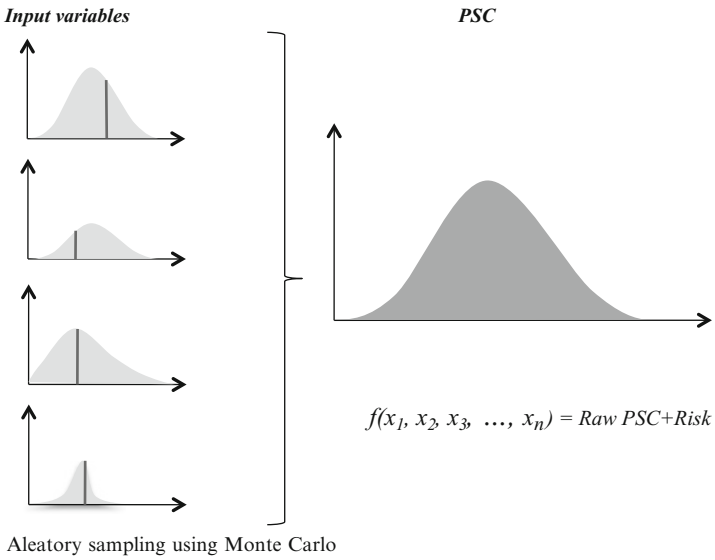

Fig. 2.9 Scheme of the Monte Carlo simulation for the PSC calculation

PSC, they are the cost components and the associated risks. Figure 2.9 presents a scheme for uncertainty modeling of the PSC using a Monte Carlo simulation.

The left side of Fig. 2.9 illustrates the random sampling for the inputs. As mentioned, associated with each input is a distribution function. The Monte Carlo simulation will generate a single number based on the distribution – a more skewed distribution will generate numbers less dispersed. The sampling is made for each one of the distributions. For each sampling, a PSC number is generated. It is through several iterations that several PSC numbers are generated and that a PSC distribution function (right side of Fig. 2.9) is found. Naturally, the skew of the PSC distribution function is highly correlated with the skew of the original distribution functions for each input. In some way, this can be interpreted as a measure of risk.

A higher risk (more uncertainty in the cost estimations or revenue forecasts) will generate distributions with longer "tails", thus providing a wide range of PSC values. Those projects that are highly standardized with low degrees of uncertainty will have a small variance. Figure 2.10 illustrates a PSC distribution function of a real case.

2.9.4.2 Alternative 2: Bayesian Network

Bayesian statistics is gaining momentum over the last two decades in several fields, including the infrastructure domain (e.g., Yin et al. 2010; Cheung and Beck 2010). The Bayesian approach is based on Bayes' formulae (2.1), which allows the conditional probability P(b|a) to be calculated given the conditional probability of $P(a|b)$ and the probabilities of $P(b)$ and $P(a)$:

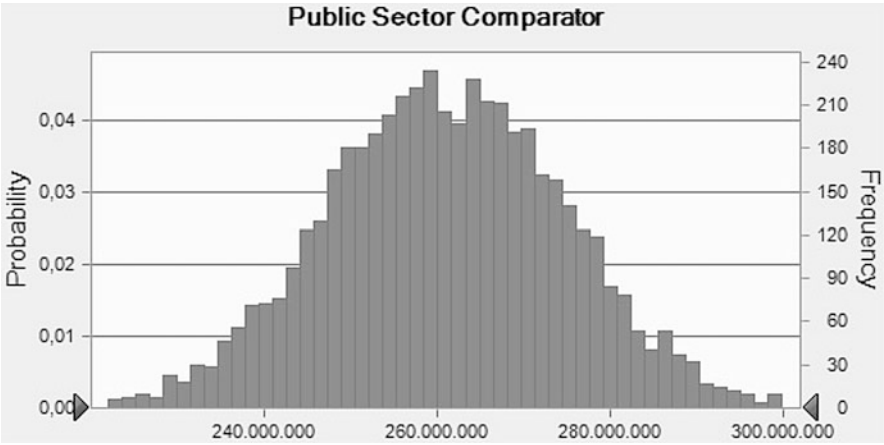

Fig. 2.10 Frequency distribution of a real PSC calculation (Units: euros)

$$P(b|a) = \frac{P(a|b)P(b)}{P(a)} \tag{2.1}$$

In this particular case study and for PSC calculation in general, BN, also called a Belief Network, is particularly useful. A BN is a representation of variables and qualitative (causal dependency of variables) and quantitative (the probability relation between variables) relationships between those variables (Janz et al. 2006).

The nodes are the variables and the arcs are the dependencies between those variables. Each parent node has a distribution, or table of *prior* probabilities, *P(Y)*, and each subsequent node has a conditional probability *P(Y/X)*, where X is the parent node. Considering a BN where x_i is a set of n random variables ($X = x_i$), the conditional probability distribution becomes:

$$P(X) = \prod_{i=1}^{n} P[X_i|pa(A_i)] \tag{2.2}$$

where *pa* (*Ai*) is the parent set of A_i.

The steps described earlier regarding risk assessment are also required to build a BN. However, it is also necessary to define the relation between the variables (nodes). Each node corresponds to a cost and has a certain risk associated with it. Figure 2.11 illustrates the BN built for the case study.

This project will require governmental subsidies, and the best bid is the bid requiring fewer subsidies. The final result of the BN is a distribution for the PSC.

Based on the best bid – *Bid'* – in this case, the lowest bid, it is possible to identify the probability *p'* of the PSC being lower (Fig. 2.12).

Taking into account this method, what is the reasonable *p'*? This has to be fixed according to the decision maker's degree of confidence. What type of error do they

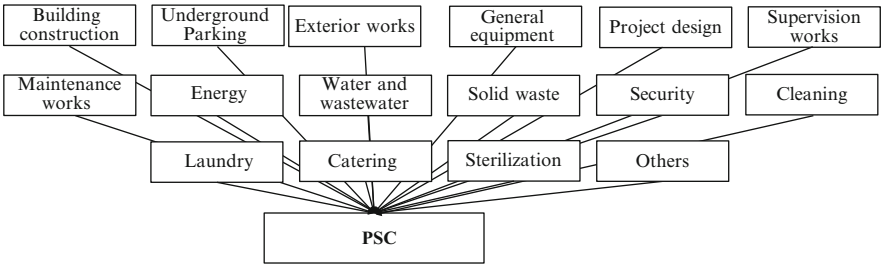

Fig. 2.11 BN for the PSC calculation of a hospital PPP (Source: Adapted Cruz and Marques 2012a)

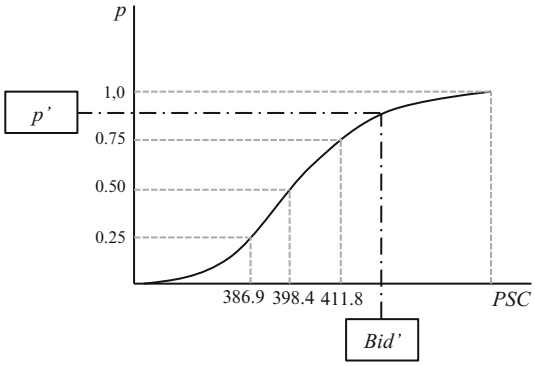

Fig. 2.12 Probabilistic comparison between the bid and the PSC (Source: Adapted Cruz and Marques 2012a)

accept? If they are only willing to accept a residual error, then the *p'* value has to be very low, and if the criteria are relaxed, p' can be higher.

2.10 Main Findings

PSC calculation remains a controversial issue. It is important to have more accurate and sophisticated models to support the decision making process for selecting the best procurement model.

Although each country has developed its own approaches to PSC calculation, it is possible to identify some trends and best practices. One of those best practices is the calculation of the PSC in different components (raw PSC, retained risk, transferred risk, shared risk and competitive neutrality). By doing so, the public sector has a more precise and insightful knowledge of the project and, above all, of the risks incurred. Even if in the UK, Canada and Australia, this segregate calculation is the norm, this is not so in other countries. For instance, in Portugal, some PSC calculations adopted this methodology, while others did not. Nevertheless, for

those countries without stable and exhaustive guidelines, the teams assembling the PSC often choose entirely different approaches. This is also evident regarding cost estimations, where entirely different approaches can be followed. Regarding cost estimation, one needs to take into account the different degrees of information available, which are dependent on each project, and therefore, the teams need to have the flexibility to select the most adequate model for each case. Not all projects have an extensive and comparable database of similar projects developed in the past.

In contrast, the choice of the discount rate needs to be administratively fixed. This does not necessarily mean that the value should be determined, but the calculation model and whether to use the same discount rate for the PSC and the PPP should at least be determined. The authors believe that the use of separate discount rates will create a comparability problem and that the use of higher discount rates in the PPP model will favor this option. Therefore, the greater valuation of risks by the private sector, e.g., higher financing costs, should be reflected as a cash-flow rather than being incorporated as an adjustment in the discount rate.

Another important issue is the fact that traditional procurement, in some cases, is not really an alternative. This means that the project either is developed through PPP or it is not developed at all. In these cases, is it worth calculating the PSC, even if we are comparing it with an alternative that does not exist? In the authors' opinion, the PSC should always be calculated for different reasons. First, it gives the public sector profound knowledge of the project: the costs, the main risks, the business determinants, the organization, etc. This is extremely helpful in designing the tender and the evaluation model. The insightful knowledge of the project helps the public sector to determine what is really relevant to evaluate in the proposals. Second, the PSC provides a useful tool to determine alternative risk sharing agreements. Even after the best bids are selected, it is often necessary to have a negotiation phase where the two best bids are tuned, which will give rise to the best and final offer (BAFO). In this phase, the PSC can provide a relevant instrument for the public sector because it allows for the assessment of the potential impact of changes in some terms. Finally, the PSC can be used as a "cap" even if traditional procurement is a real alternative. This means the PSC can be used to set a maximum base cost. This provides a benchmark and a tool to foster the private sector to deliver higher VfM solutions.

There is also the procedural issue of whether to disclose the PSC, for which there is no definitive answer. There are advantages and disadvantages to both alternatives. If the PSC is disclosed, it allows for bidders to validate the hypothesis of the calculation. If there is any mistake or misjudgment, it can be detected, thus improving the original PSC calculation. However, if the PSC is too conservative or, in other words, if the private sector expertise allows for significant savings compared with the PSC, the bidders might adopt a less aggressive approach, presenting bids closer to the PSC. If the process is really competitive, i.e., if there is a sufficient number of bidders ensuring real competition, this is not a problem, but the fact is that not all procedures are truly competitive.

Contractual Flexibility

3

3.1 Introduction

Infrastructure PPPs suffer from a major paradox. On the one hand, they are built to last several decades. During this time, several unplanned events take place, some related to the project themselves and others result from the global context in which these projects operate. On the other hand, these PPPs are, most of the time, supported by contractual arrangements that both agents intend to be as exhaustive as possible to foresee any possible contingency and to design the adequate mechanisms to address these contingencies. In fact, many of the contracts have an underlying OBC (generally included in the annexes), where it is possible to find all cash-flow projections, supported on macro-economic estimations (interest rates, inflation rates, economic growth, etc.).

This OBC assumes that the project and all surrounding context will behave according to plan. Here lies the major paradox: developing capital-intensive, highly complex socio technical systems that require huge sunk investments while assuming that the "world" will work perfectly according to the "spread sheet model". This "wishful thinking" of professionals rarely takes place, and the reality is generally very different from the projected scenarios. This has less to do with the higher or lower technical expertise of modelers than the complexity of long term forecasting.

Over the last decades, econometric models have undergone important improvements, but the ability to estimate the economic performance of regions or countries and the respective impact on infrastructure projects is still far from accurate (Flyvbjerg et al. 2003). The truth is that it will never be possible to estimate accurately the key variables of infrastructure projects. As Neufville and Scholtes (2011) claim, "*we need to recognize that forecasts are 'always wrong' and that our future is inevitably uncertain*".

Nevertheless, there is still a large emphasis being placed on these forecasts, and their inaccuracy has been a major source for renegotiations. This is partially because of the incomplete nature of contracts (Hart and Moore 1999), as discussed in Chap. 3, and partially due to the opportunistic behavior of agents, both

C.O. Cruz and R.C. Marques, *Infrastructure Public-Private Partnerships*,
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concessionaires (Williamson 1976; Hong and Shum 2002; Ubbels and Verhoed 2008) and the public sector (Engel et al. 2006; Guasch and Straub 2009; Cruz and Marques 2013b).

As it will be shown in Chap. 5, it does not take long for stakeholders to realize that the contract has failed and that the contract does not have the capacity to address the new circumstances and, therefore, needs to be revised, i.e., renegotiated.

The path to overcome uncertainty involves the attempt to design "flawless" contracts as completely as possible, which leads to a certain rigidity (Marques and Berg 2010; Bettignies and Ross 2009). Traditional contract design has been supported by the idea of foreseeing the future and designing the contract to cope with certain future conditions.

Is this rigidity beneficial for efficient management of the infrastructure/service? Bettignies and Ross (2009) claim that there may be a trade-off between the efficiency and the contractual rigidity. This is supported by the argument that an exhaustive description of infrastructure requirements and/or services to be provided (types and quantities), among other specifications, can limit the concessionaires' ability to adopt a more aggressive and pro-active approach to adapt the infrastructure/services to new requirements. The traditional approach is essentially passive. The concessionaire has to follow the pre-determined investment plans and the contracted service for the (long) duration of the contract. This is usually determined and designed by the grantor, upon whom often relies the cost of re-adaptation.

Increasing attention is being paid to measures aimed at reducing risk exposure, but most studies on this issue have been related to the financing aspects (Shah and Thakor 1987; Fowkes 2000; Megginson 2010; Aldardice et al. 2001). This work will go a step further, first, by identifying the possibilities of introducing flexibility into a PPP contract and, second, by quantifying, through a case study, the economic gains of such a contract design model.

This chapter will delve into the main risks and uncertainties behind PPP projects, which are behind the argument for the principle of developing more flexible contracts. Next, it will identify the several types of flexibility, describing the existing classifications and proposing a matrix that integrates some of those classifications. It will also discuss the main valuation mechanisms, particularly the real options (RO) theory, which has been the cornerstone for valuing flexibility, and also where and how to introduce flexibility in contracts, revisiting the existing literature on flexibility. A case study will be further developed to test the value of flexibility. The case study is a healthcare infrastructure PPP. Finally, the main conclusions are drawn.

3.2 Risk and Uncertainty in PPPs

3.2.1 Main Sources of Uncertainty

As previously stated, the uncertainty gives rise to several types of risk. These can have different natures, different impacts and different probabilities of occurrence, as highlighted in Section 3. There is no such thing as an exhaustive list of risks. Generally, the literature and the professional practice focus on the most relevant risks. These lists usually cover the majority of events that can occur and that affect the economic performance of the project or the PPP arrangement.

Next, a list of risk based on the work performed by Bing et al. (2005) and Loosemore (2007) is presented:

- Statutory/planning risk: planning process and obtaining permits;
- Misspecification of output requirements risk: the service defined in the contract is not clear or contains errors;
- Design risk: errors committed during the design stage that may result in delays, cost overruns or inadequacy to the requirements;
- Construction risk and time schedule risk: problems in construction activities and a subsequent cost increase and time delay;
- Operation risk: factors that can increase the cost of operating the service/infrastructure;
- Demand risk: the risk that the demand (or consumption) is lower than expected;
- Risk of changes in public needs: the output specifications are no longer valid because of changes in society's requirements;
- Legislative/regulatory: modifications in legislation and regulatory framework;
- Financial risk: changes in interest rates; and
- Residual value risk: considers the possibility that the value of the infrastructure at the end of the contract is lower than expected.

Some risks can be found in PPP projects as referred to in Sect. 2. Nevertheless, there are three particularly important risks that will support the modeling of the flexible design in this chapter:

(i) Construction – most PPP projects generally involve large costs and complex construction engineering;
(ii) Demand – the demand (or consumption) is a critical variable for the Economic and Financial Re-equilibrium model (EFR), and the return on investment in highly sensitive to this variable; and
(iii) Financing – the large and sunk investments required involve a great exposure to financial markets (because of the large debts).

Each of these risks makes PPP projects particularly vulnerable and may affect the economic value of the project. This issue becomes even more relevant when there is not a single agent coping with these effects but a rather complex matrix of risk sharing between two agents – the public and the private sectors – often not as clear and objective as one might expect. This is one of the reasons for so many contractual renegotiations, as argued by Engel et al. (2006) and thoroughly discussed in Chap. 5.

3.2.2 Construction Risk

Most infrastructure PPPs imply a great amount of investment in the construction of the infrastructure, even though this is not always the case because some PPP projects are developed just for the service. In fact, the capacity of the private sector to better address this risk and its ability to finance these investments is one of the main reasons for considering the PPP option in the first case.

Why is construction risk so relevant? The risk in construction is not always easy to mitigate. This is because of particularities of the construction sector. Among them, the following aspects are particularly relevant:

- Most large construction projects are not standardized. It is very unlikely that any construction firm will build two exactly same dams or roads in its lifespan; most, if not all, large infrastructure are unique and require a great deal of specific features; they often require complex and unique construction systems (Zavadskas et al. 2010), and the low degree of standardization of the design affects the ability of firms to accumulate knowledge on a given project type (Prencipe and Tell 2001);
- Quality control is not easily assured: because the output is not standardized but also because of the workers' poor labor skills, working methods and assuring high levels of quality control is a complex task;
- Highly vulnerable to climatic conditions: heavy rains, snow or even hot weather are very likely to cause disruptions in the construction activities and are not controllable by project managers;
- Large geotechnical and geological uncertainty: the construction of roads, tunnels, dams, airports, among other types of infrastructure, are highly vulnerable to local conditions, which, in many cases, are not entirely known until the excavations start; this adds great risk to the process;
- There is a significant time gap between the moment the project design is finished and the construction begins (Yu et al. 2005; Touran and Lopez 2006); this has implications on the costs, particularly in fast growth economies, where there may be a problem of inflationary cost overruns (Kaming et al. 1997) but also at the level of new materials and construction methods that were not known at the time the project was designed. Furthermore, the government requirements and, therefore, the specifications change over time.

All these characteristics of the construction activities ultimately result in the well-known cost deviations. Flyvbjerg et al. (2003) analyzed several types of projects and concluded that on average, there is a cost escalation of approximately 27.6 % (Table 3.1).

Looking at Australian water projects, Liu and Napier (2010) also found the same pattern of cost overruns but with a lower average escalation (7.4 %).

More authors have found the same pattern, such as Raftery (1994), Bruzelius et al. (2002), Flyvbjerg et al. (2004), Odeck (2004), Niazi et al. (2006) and Cantarelli et al. (2010).

What is strange is that the deviations are always positive, meaning that it seems to be biased toward overruns. Kujawski et al. (2004) and Flyvbjerg et al. (2006)

Table 3.1 Average cost escalation by the type of project (constant prices)

Type of project	Projects (No.)	Average cost escalation (%)	Standard deviation (%)	Level of significance
Rail	58	44.7	38.4	<0.001
Fixed links	33	33.8	62.4	0.004
Road	167	20.4	29.9	<0.001
All projects	258	27.6	38.7	<0.001

Source: Adapted Flyvbjerg et al. (2003)

argue that if this behavior is known and systematic, then it should be possible to improve the cost forecasting methods. Altshuler and Luberoff (2003) also suggest that the questions of political bias and institutional design can contribute to cost overruns, although these should be considered as non-systematic causes (Liu and Napier 2010).

As previously stated, the ability of the private sector to address this risk is one of the main arguments for PPP development. In fact, some researchers found evidence that the private sector can decrease construction costs and, particularly, cost overruns. McKee et al. (2006) found regarding hospital PPPs that 76 % of the projects developed under this arrangement were delivered on-time and 79 % were on-budget, while under traditional procurement models, the percentages dropped to 30 % and 27 %, respectively.

Notwithstanding, development of PPP projects is still a major source of risk, and the private sector is well aware of that. It is not rare for infrastructure PPP concessionaires to refinance the project once the construction is over. This refinancing brings more advantageous conditions to the partners because the lenders consider that a significant risk (construction) is eliminated at this stage.

3.2.3 Commercial Risk

Commercial risk is highly related to errors in forecasts. Neufville (2004) claims "forecasts are always wrong". Why is it difficult to accurately forecast demand for a certain service? There are several different ways of performing forecasts, but for PPP projects, they are generally based on highly complex econometric models. These models take macro-economic variables as inputs along with several variables specific to the sector. They are built upon historical data when available and forecast the dependent variable into the future, sometimes incorporating the "experts' feeling".

It is important to notice that most forecasts are performed for very long periods of time. Who can forecast the growth of the gross domestic product (GDP) for such a period or even the variation in interest rates?

This uncertainty will always exist no matter the computational improvements made. However, one would expect that the frequency (p) of the errors of the

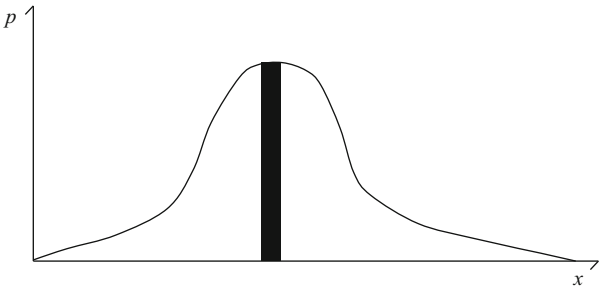

Fig. 3.1 Normal distribution of error

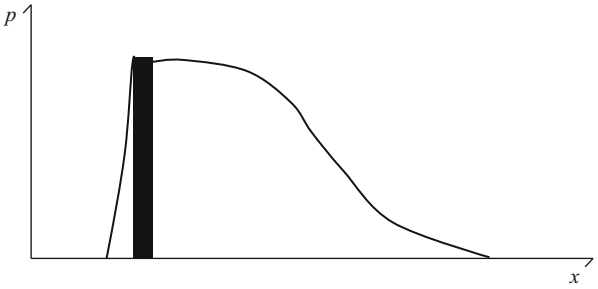

Fig. 3.2 Asymmetric distribution of error

forecasted variable (x) should be approximately asymmetrically distributed, as shown in Fig. 3.1.

The reality shows a different scenario (Fig. 3.2). Flyvbjerg et al. (2004), Mackie and Preston (1998) and Bain (2009), among others, have studied the phenomenon known as optimism bias, or the tendency to overestimate demand.

The problem with the overestimation of demand is that it has been one of the major causes of renegotiations, as shown in Chap. 5. In transportation projects, Skamris and Flyvbjerg (1997) have found a systematic positive deviation of a 20–60 % lower demand than estimated. Baeza and Vassallo (2010) found the same pattern in road projects. Because of these errors, many costly renegotiations took place. The contracts foresaw the possibility of compensation to the concessionaire in the case that the observed demand did not reach what was planned. Renegotiations due to forecast errors are also frequent in the water sector. Marques and Berg (2011b) found evidence of the same optimism bias in water consumption. They attributed this fact to the need to justify the financial viability of the projects and noted two important consequences, the first being the renegotiation immediately after signing the contract (at the end of the first year) and the second one being the fact that the most optimistic proposal, not the best bidder, is chosen (which, due to the highest fictitious consumption, presents a lower winner tariff).

Even in those cases where there is not a conscious intention of overestimating the benefits of the project, the teams involved with the project generally do so. This is a non-insurable risk and one of the major causes for renegotiation.

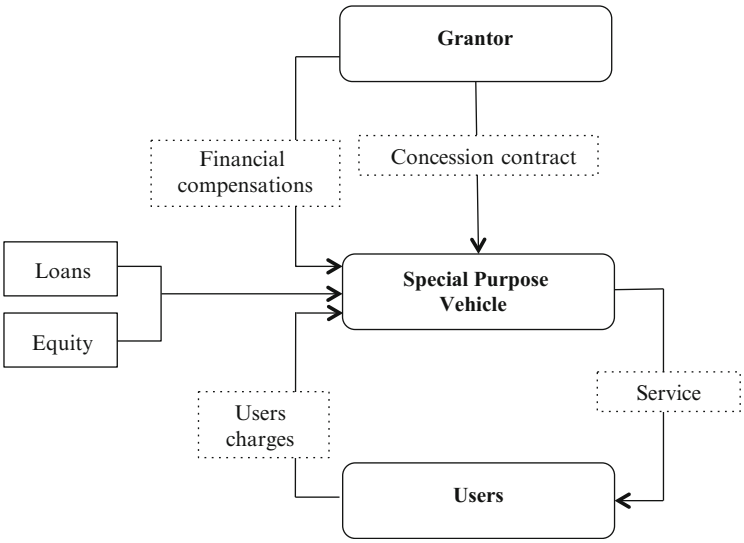

Fig. 3.3 Example of a financing structure of a PPP project

3.2.4 Financing Risk

Most PPP projects involve large and sunk investments. Infrastructure is, generally, capital intensive, and this can lead to a large exposure to financial market fluctuations. First, it is important to analyze how infrastructure is financed.

The financing of infrastructure is often supported by several sources (represented in Fig. 3.3):

- Private equity;
- Debt;
- Governmental funds (local, regional, national or even supra-national, such as EU funds); and
- User charges.

Figure 3.3 provides a general overview of the financing structure of PPP projects around the special purpose vehicle.

The equity is provided by equity investors and shareholders, which in most cases are the members of the consortium (construction companies, banks and depending on the type of project – transport operators, environment and health related companies). There is an empirical rule followed in most projects for the adequate level of the percentage of equity, which should be approximately 20–30 %. The lenders provide debt, which may have different maturity periods and are generally the first expenditure to be paid. Governments can provide different types of funds. Some funds are exclusively used to finance the construction of the infrastructure (e.g., EU cohesion funds), while others are subsidies generally provided on an annual basis to guarantee the necessary revenues to achieve the financial balance and provide the contractual rate of return. Finally, users' charges are also an

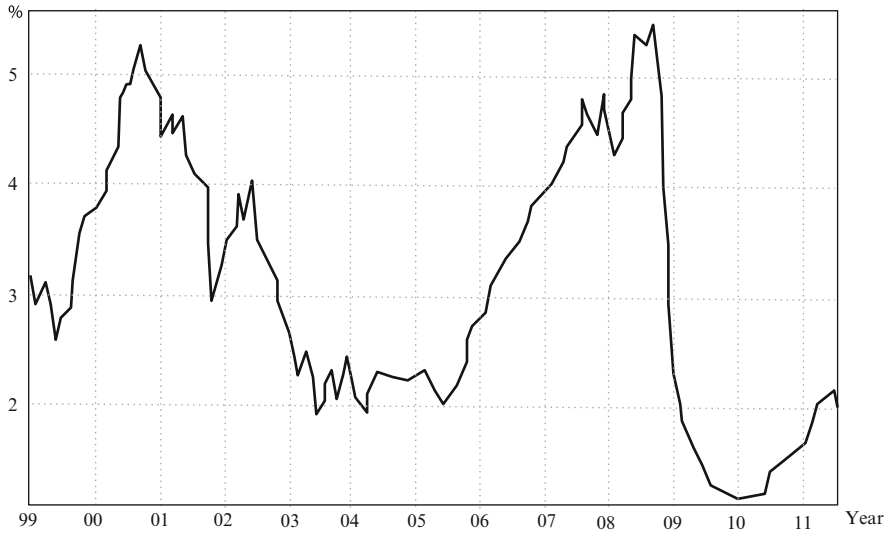

Fig. 3.4 Changes in the Euribor (1Y) in the period 1999–2011 (Source: TradingEconomics.com)

important source of cash-flow. The risk associated with this cash-flow is directly related to the commercial risk discussed in the previous section.

Debt is usually the main financing component of the projects. However, the markets able to finance the investments through debt in the last years do suffer from great uncertainty. Figure 3.4 presents the evolution of the Euribor with a 1-year maturity period. The extraordinary level of variability is clear, and it is difficult to identify, for the 12-year period, a predominant value.

3.3 The Concept of Flexibility

3.3.1 Uncertainty and Flexibility

The concept of flexibility is a cross-discipline concept covering distinct scientific areas such as biology, economics, regional science, electronics, industrial engineering, operations research, among many others (Saleh et al. 2009). In the field of biology, Gifford (2003) defines flexibility as the ability of living organisms to adapt to changing conditions.

The concept of flexibility is intrinsically related to uncertainty. Flexibility is only required when it is not possible to foresee the future. Facing that uncertainty, flexibility emerges to allow systems to evolve and accommodate the unveiling circumstances. Some authors have been studying how the concept of flexibility can be adapted to infrastructure (Neufville et al. 2008), and there has been an effort to further elaborate on the application of flexibility in PPP contracts (Cruz and Marques 2013c).

Why apply flexibility in PPP projects?

As mentioned in previous sections, PPP projects are extremely vulnerable to several types of risks. These risks arise from the uncertainty in the macro-economic context but also in environmental, technological, and legal issues. Reality does not always behave according to the pre-determined forecasts and assumptions established when the contract is signed (as discussed in Chap. 3). The ultimate consequence, as shown in Chap. 2, is renegotiation.

Quoting Dixit and Pindyk (1994):

> The irreversibility of investments has been neglected, despite its implications for spending decisions, capacity choice, and the value of the firm. When investment is irreversible and future demand or cost conditions are uncertain, investment expenditure involves the exercising, or 'killing', of an option – the option to productively invest at any time in the future. One gives up the possibility of waiting for new information that might affect the desirability or timing of the expenditure; one cannot disinvest should market conditions change adversely. This last option value must be included as part of the cost of the investment.

The uncertainty generally regards two subsets of aspects (Neufville and Scholtes 2011). One is related to the external conditions, such as the economic environment, the cost of capital and the evolution on demand. The other concerns aspects of the system itself, for example, the production cost, the reliability, the effectiveness and efficiency, among others.

Over the 20, 30 or more years of contract duration, the circumstances will change significantly and may require profound adaptations to the project characteristics. The hypothesis that many authors have discussed is that higher flexibility can decrease the probability of renegotiation while increasing the contract performance. Because it is not possible to determine the exact evolution of all the key parameters, the project/contract should be imbedded in the flexibility to accommodate future changes.

However, there are some issues:

(i) These imply a greater risk assumption by the private partner. Is it possible?;
(ii) How should the bids evaluation models be adapted to accommodate uncer tainty?; and
(iii) Does flexibility have any impact on the model's structure (e.g., does it imply bundling infrastructure and operation in some cases?)?

Until now, flexibility was understood as a theoretical concept. There are several types of flexibilities and several classifications. The next sections will look into these differences.

3.3.2 Flexibility "In" and "On" Projects

One of the first authors to address this area has proposed a dual classification for flexibility: "in" and "on" projects (Neufville 2004).

Flexibility "in" projects: those flexible options that are imbedded in the project, meaning the physical design options that allow for the infrastructure to evolve

over time. One example might be the possibility to reinforce a building's structure to allow for the posterior adding of extra floors. This type of flexibility generally involves changes in the physical design or even in the choice of the technological system to allow for the necessary adaptation over time (Zhao and Tseing 2003; Weck et al. 2004; Neufville et al. 2008).

Flexibility "on" projects: unlike flexibility "in" projects, "on" projects assume that the infrastructure is a single object with no possibility of adaptation. The flexibility concerns the hypothesis of differing in time, abandoning, or even switching the project or part of it (Leslie and Michaels 1997; Amram and Kulatilaka 1999; Wang 2005).

Chiara and Kokkaew (2009) have built the concept of "contractual flexibility analysis" (CFA) as a particular case of flexibility "in" projects. These authors have extended the concept to the study of flexibility within "contract structuring projects" where we can find the PPP schemes because there is a contractual agreement setting the object, risk allocation and responsibilities for each partner.

The authors distinguish RO analysis from CFA. The first type considers both exogenous and endogenous flexibility options ("on" and "in" projects). The second type is related only to the endogenous options ("in" projects) and, within those, only the contractual options. Both types are illustrated in Fig. 3.5, adapted from Dong and Chiara (2010).

These authors provide a procedure for flexibility analysis in PPP projects. The procedure, represented in Fig. 3.6 and adapted from Dong and Chiara (2010), involves two steps: first, identifying the individual flexibilities (for each agent) and, second, adding endogenous interdependent flexibilities between the two agents.

The principle behind this proposal is that the interdependent flexibilities added in step II allow shifting some risks (total or partially) from one agent to the other to mitigate the downside risks. They act at the level of risk sharing but are not better adjusted to any unveiling circumstances of the project. Examples of these interdependent flexibilities are contingent claims. In some way, the EFR model, presented in the Chap. 3, is a form of flexibility. It dictates the conditions to initiate the renegotiation and establishes the rules to manage the process. Unfortunately, it is also used to shift risk from the concessionaire to the public partner (e.g., shadow toll highways in several countries[1]).

Acknowledging that there will be variations in the concession main key performance indicators (KPIs), the contract allows some "variability" to accommodate small variations. The question is that with very low KPI triggers, as discussed, there is no true flexibility. Any slight deviation will trigger the renegotiation.

[1] As an example, the shadow toll highways in Portugal were changed to real toll highways. To accept this renegotiation, the concessionaires required that the government assume the demand risk and pay an availability fee for the highways. This eliminated one of the major sources of uncertainty for concessionaires at the expense of the public budget.

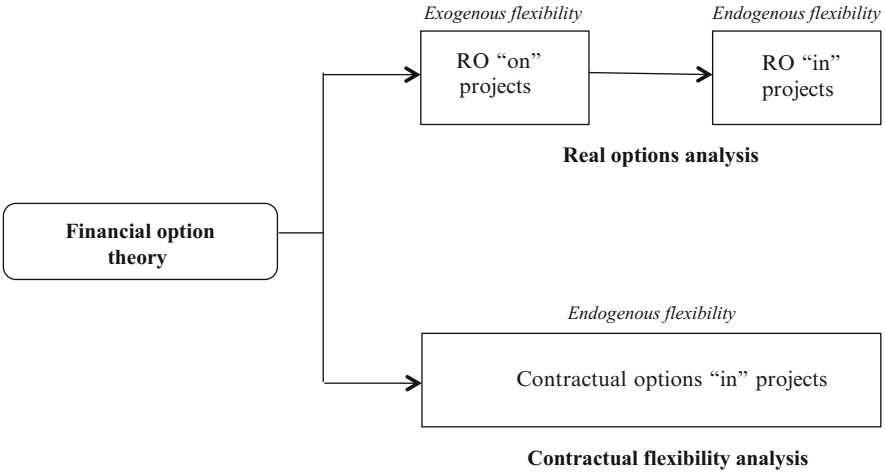

Fig. 3.5 RO analysis and contractual flexibility analysis

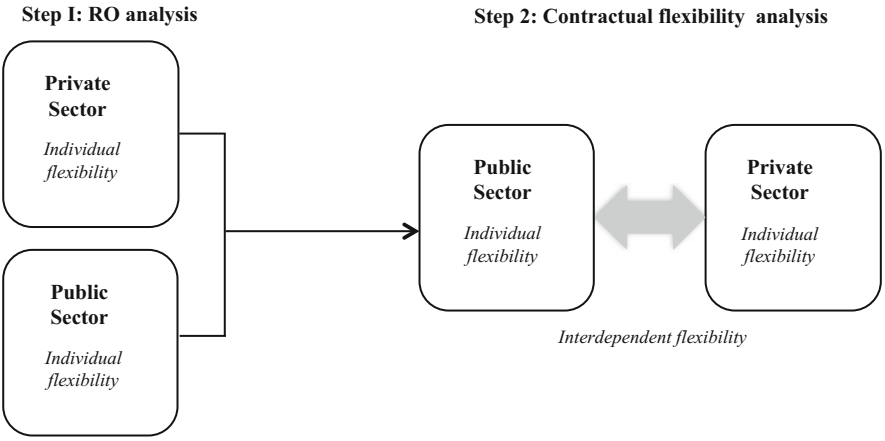

Fig. 3.6 Procedure for flexibility analysis in PPP projects

More examples can be found, for example, the "collar option" to manage revenue risk in toll highways (Shan et al. 2010). The rationale of the "collar option" is similar to the EFR because it allows the concessionaire to claim subsidies.[2]

Introducing interdependent flexibilities allows deviating risk but at the cost of the partner that "receives it". To mitigate the downside risk, one partner activates the option (contingent claim) and moves the risk to the other partner. The real experience with PPP projects shows that this is generally performed at the expense of the public sector.

[2] For more on the "collar option", see Dailami et al. (1999), Irwin (2003) and Chiara et al. (2007).

3.3.3 Strategic, Tactical and Operational Flexibility

Neufville and Scholtes (2006) proposed a different classification for flexibility, which is based on the decision level of the option:

Strategic flexibility: taken at the top level, with a very low degree of irreversibility (possibility to "switch off" the option) and a high cost (e.g., option of building a new runway in an airport); generally, this is once in a life time decision;

Tactical flexibility: taken at a lower management level, with a moderate cost and degree of irreversibility (e.g., readapting an airport terminal area); and

Operational flexibility: taken at an operational level, with a low cost of decision and generally exercised several times a year (e.g., managing the number of open gates in an airport terminal).

Table 3.2 presents a comparison among the different types of flexibility.

Neufville and Scholtes (2011) present three categories for flexible designs:

- Changes in size: the flexibility is given by a modular design, with the capacity being increased according to market needs (e.g., this is what happens in highways when a third lane is built to accommodate traffic increases);
- Changes in function: the flexibility allows the system to change its function or accommodate new functions; and
- Protection against events: the systems hold mechanisms that will mitigate the impact of the occurrence of accidents (e.g., power generators in hospitals).

3.3.4 New Matrix Classification of Uncertainty

Until now, several different categorizations for flexibility were presented. However, they can be related. The interdependent flexibilities presented by Dong and Chiara are a type of flexibility "in" projects and concern mechanisms able to redistribute risk over the agents. Within the class of flexibility "in" projects, there are also individual flexibilities that concern the infrastructure/service itself.

The categorization proposed by Neufville and Scholtes (2006) brings a category based on the level of the flexibility, including a managerial perspective.

Starting at the strategic level (top management decisions) and ending at the operational level (lower levels of decision), Table 3.3 presents a categorization for the flexibility in PPP contracts.

In addition to the double entry categorization in the matrix, the options should also be categorized according to their nature: financial (e.g., interest rate cap), legal (step-in rights), and physical (capacity increases).

In fact, to correctly categorize all available options in a PPP contract, each matrix should be developed for each nature of options. The options are not mutually exclusive and can co-exist in the same concession. They can also have different exercise models, including timing options, growth, staging, exit, flexibility, operating and learning, to use the categories proposed by Amram and Kulatilaka (1999).

Table 3.2 Comparison of the different levels of flexibility

	Strategic	Tactical	Operational
Impact on future economic gains	High	Moderate	Low
Public scrutiny of decisions	Very high	Moderate	Low
Cost of decision	Very high	Moderate	Low
Reversibility	Very low	Moderate	Very high
Decision maker level	Politicians	Directors	Technicians
Valuation techniques	RO, game theory, multicriteria analysis, DT, CBA	RO, CBA	RO Design structure matrix (DSM), CBA

Source: Adapted Neufville and Scholtes 2006

Table 3.3 Classification for flexibility in PPP contracts

		Location of flexibility		
		Flexibility "in" projects		Flexibility "on" projects
		Interdependent	Individual flexibility	
Scale	Strategic	Step-in rights	Capacity modular development	Defer
		Flexible duration contracts		Abandon project[a]
		Concessions' capture		
	Tactical	Revenue guarantees	Investment in alternative production lines	n.a.
		Cap on interest rates	Securitization and SWAPS	
		EFR model	Technology changes	
	Operational	Lease back operations[b]	Switching the allocation of spaces between services (hospital)	n.a.
		Short term changes in property		

Source: Cruz and Marques 2013c
In each cell, some examples are presented, but they should not be regarded as an exhaustive listing of all possible flexibilities
[a]Different from the concessions' capture
[b]Lease back operations consist in a change in the property of the concessions' assets

3.3.5 Estimating Distributions of Future Possibilities

Neufville and Scholtes (2011) propose a five-step process for defining the distribution of future possibilities as described in Table 3.4, which include the following: (1) Identifying the critical variables; (2) Analyzing historical trends; (3) Identifying trend breakers; (4) Establishing forecast (in) accuracy; and, (5) Building a dynamic model.

Table 3.4 Process to define the distribution of future possibilities

	Strategic
Identify the critical variables	When dealing with PPP projects, the number of critical variables able to affect the systems' performance in the long run is extremely high. To decrease the complexity of the analysis and, consequently, the transaction costs involved, it is necessary to establish a hierarchy of the critical factors, focusing on the most relevant (following the managerial approach know as 20/80[a]). These critical variables can be quantitative (e.g., demand) or qualitative (e.g., regulatory scheme). In this second case, there will not be any forecast associated with the variable, but it might influence other variables
Analyze historical trends	For the variables identified in the previous step, it is necessary to analyze historical data. The process should be as quantitative as possible, but it is often necessary to use qualitative data or informal knowledge from experts. This is particularly relevant when no prior information exists on certain variables (see more in Cruz and Marques 2012a). The process involves two main activities: understanding and assessing the data
Identify trend breakers	This step is designed to understand the historical trends that help to frame the forecast in the next step. The historical behavior of the variables is not always linear or stable, but it is subject to some events that cause disruptions. Identifying the historical trend breakers can be useful in understanding the patterns, but most important, it is necessary to forecast the future trend breakers for each variable
Establish forecast (in)accuracy	The two previous steps will help determine the accuracy of the forecasts. The forecast can be determined based on several statistical and econometric models with different complexity and distinct data and computational requirements. All prior information regarding forecasts should be used (e.g., the acknowledgement of optimism bias in most demand forecasts should be used for an unbiased forecast)
Build a dynamic model	The final step is to build a model that will incorporate each distribution previously determined for each variable. The model will allow estimating future distributions, preferably through a random generation model such as Monte Carlo

Source: Adapted Neufville and Scholtes 2011

[a]The 20/80 rule, or Pareto principle, is widely used in management consultancy and claims that 80 % of the results can be explained with 20 % of the causes

3.4 Valuation Methods

3.4.1 Types of Methodologies

Investment projects can be evaluated using different methods: simple DCF analysis, decision analysis (including decision trees – DT, utility functions and probabilistic risk assessment), and RO analysis. The next section will provide a brief description of each model to help understand the models used in this paper.

3.4.2 Discount Cash-Flow

The DCF requires the estimation of (*i*) the future cash-flow stream and of (*ii*) the discount rate. The latter usually corresponds to the risk-adjusted average cost of the capital, determined through the WACC. The decision in DCF is rather simple because the project should go forward if the NPV is higher than zero, and if the NPV value is lower, it should not be developed (see more in Geltner and Miller 2001). The DCF does not explicitly account for uncertainty nor does it allow for alternatives or changes in the projects' characteristics. Algebraically, it can be computed by the following equation:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} \tag{3.1}$$

where CF_t is the cash-flow in period t, r is the discount rate, and n is the number of time periods (typically fiscal years). There are two different types of DCF methods: free cash-flow (FCF) and capital cash-flow (CCF).

The FCF model is the most widely used and differs from the CCF in the treatment of tax benefits. In the CCF, the cash-flow include the estimated tax benefits adjusted to the changes in the capital structure. This is performed considering the cost of debt as an outflow. Conversely, the FCF incorporates tax benefits into the average cost of the capital rate.

Although algebraically equivalent, when addressing investment projects with high levels of indebtedness and a capital structure with a changing geometry over the project lifespan, the CCF is a much more appropriate model (Esty 1999).

3.4.3 Decision Analysis

Decision analysis, as part of the RO analysis, brings the uncertainty into the mathematical formulation of the model. To perform decision analyses, it is necessary to identify the possible choices available to the decision maker and the respective outcomes and probabilities.

One application of decision analysis, which is likely the most common, is DT. In DT, the nodes represent moments where the different events might occur (e.g., increasing capacity). Each of these events holds a certain probability of occurrence that can be hard to calculate.

Algebraically, one can compute the decision analyses by the following equation:

$$EV = \sum_{i=1}^{n} P_i \times O_i \tag{3.2}$$

where EV is the expected value, P_i is the probability of outcome O_i, and n is the number of possible outcomes.

3.4.4 Real Options

The main rationale behind RO is that it is possible to extract value from uncertainty. RO allow the transformation of what is observed as a threat into an opportunity, thus providing a valuable contribution. RO might be described as a measure of added value of flexible solutions under an unstable environment. If correctly used, they allow one to identify embedded options in investment projects and support strategic project design (Trigeorgis and Mason 1987). To assess the potential for incorporating flexibility in partnerships, a multi-level approach will be followed. Flexible options can exist at a strategic, tactical and operational level, and different methodologies will have to be used. For example, at a strategic level, game theory and multicriteria analysis will be of great usefulness (Smit and Trigeorgis 2003).

Luehrman (1998) and Kodukula and Papudescu (2006) argue that RO are a sub-product of financial options. The application of the option theory to "real" assets is not direct because the volatility associated with the fluctuation of market prices (in financial options) corresponds to several types of uncertainty in real assets. Infrastructure is not traded. Therefore, some proxy has to be found to address this constraint (Copeland and Antikarov 2001). The market volatility is replaced by the demand volatility.

DCF does not correctly evaluate projects with variable geometries over the "concessions period". However, there is another important advantage when using RO. In RO, the risk is incorporated as cash-flows, unlike simple DCF, where the risk is imbedded in the discount rate. This allows for a more transparent analysis and quantification of risk, ultimately resulting in a better understanding of the main risk components of the project (Latimore 2002). The methodologies adopted for the evaluation of the options can be found in Copeland and Antikarov (2001), Brennan and Schwartz (1985), Kester (1984), Kulatilake (1993), Mason and Merton (1985), Panayi and Trigeorgis (1998), Park and Herath (2000), Ross (1995) and Trigeorgis and Mason (1987).

The option value is given by the difference between two scenarios: the OBC and the scenario containing the option:

$$Option\ Value = NPV_{Flexible} - NPV_{OBC} \tag{3.3}$$

The option value determines if the flexibility should be built. If it is greater than zero, then the option should be built, and if it is lower than zero, it means that the flexible option does not bring any value. In a stock market, the *option* to buy (a call option) or sell (a put option) an asset at a fixed price (the *strike* or *exercise* price) at or before the expiration date of the option is *a right and not an obligation* (Brealey and Myers 2001).[3] The option will only be exercised if the price of the asset is

[3] An option that can only be exercised at the expiration date is called a *European option*. One that can be exercised at any time until the expiration date is called an *American option*.

below the strike price, in case of a call option, or if the price of the asset is greater than the strike price, in the case of a put option.

The increase factor, u, and the decrease factor, d, in each node are determined by formula (3.4) and (3.5) (Cox et al. 1979):

$$u = e^{\sigma\sqrt{\Delta t}} \tag{3.4}$$

$$d = \frac{1}{u} = e^{-\sigma\sqrt{\Delta t}} \tag{3.5}$$

where σ is the volatility of demand, and Δt is the time interval (1 year).

The original Black and Scholes (1973) formulae was developed assuming a continuous price option. Later, Cox et al. (1979) adapted the formulation for discrete periods (1 year in our case).

After calculating the binomial lattices, we calculated the cash-flows tree. Then, using a "backward induction process", the project was valuated, and the optimal decisions for the options exercised were determined. For each possible scenario, at each node, one must calculate the probability that will influence the final evaluation of the project, basically simulating a random walk in each binomial tree.

As suggested by Bollen (1998, 1999), for "regime switching models" and "product life-cycles", this probability can be calculated according to the following formulae:

$$p = \frac{e^{\mu\Delta t} - d}{u - d} \tag{3.6}$$

where u, is the increase factor, d, the decrease factor and Δt is the length of each period. Regarding the calculation models of cash flows, two separate models were developed. The most traditionally used model is the FCF and the most accurate for large-scale infrastructure with high debt leverage is the CCF model.

3.5 Case Study: Flexibility in a Hospital PPP

3.5.1 Organization and Functions of a Hospital

A hospital is typically a key element in the health system. We can look at the hospital from two perspectives: the portfolio of services offered and the organization of the infrastructure and services. This basically corresponds to looking into the system from outside and from inside.

From a service-related perspective, the typical portfolios of services a hospital might provide are urgencies, ambulatory and inpatient treatments (includes surgeries, consultations, diagnostic exams, etc.), and research/teaching for university hospitals. Ambulatory and inpatient services include several medical

specialties such as anesthesiology, general surgery, neurology, internal medicine, radiology, pediatrics, gastroenterology, stomatology, cardiology, psychiatry etc. From an intra-system perspective, the hospital can be divided into the physical infrastructure, soft facilities, and medical services. The level of "outsourcing" in each of these services is what defines the several models in hospital PPPs. The simplest model is related just to the infrastructure. In a typical DFBO, concessionaires are responsible for building (or upgrading) the infrastructure and for assuring the maintenance for a pre-specified period (the UK, Canada and Australia use this model). It is not unusual that soft facilities (cleaning, sterilization, security, parking, catering, waste, energy, water supply, wastewater, etc.) are also under the responsibility of the concessionaire.

The other model, which is more complex, also includes medical services – staff (physicians, nurses, etc.) management, medical and clinical equipment, etc. In this case, the concessionaire manages the entire hospital (e.g., Spain and Portugal). The rationale for the second model comprises the synergies that might arise from a coordinated management infrastructure plus clinical services. This matter is developed in the next section.

In a simpler way, a hospital can be commonly defined as an institution where patients obtain medical treatment (Barros 2009), though this definition is far from complete. In fact, there are several other places where medical treatment is provided and should not be considered hospitals. The definition of hospital requires inpatient treatments, and hospitals are often places where research and teaching takes place. However, once again, there are also institutions where inpatient treatments happen that are not hospitals (for example, nursing homes). Furthermore, research/teaching can also be found in universities.

Hospitals are complex systems for several different reasons:

(i) Their configuration and special arrangements are difficult to change over time, though disease patterns and technological requirements keep evolving, leading to a complete reorganization of facilities or even closure (Thompson and Mckee 2004). This is also observable at a cultural level because hospitals face entrenched professional attitudes;
(ii) Their scope is not stable, i.e., the definition of which conditions are treated inside the hospital perimeter and outside, for example, in primary care or continuum health care units, depends on political will;
(iii) The stakeholders involved in health care provision (pharmaceuticals, equipment industries, laboratories, universities, government, patients, local communities, among others) place tremendous pressure on hospital management, and their interests and objectives are far from aligned; and
(iv) The type and duration of medical treatments also change dramatically. For example, between 1970 and 1999, the average stay for a normal delivery by a mother decreased from 7 to 3 days.

3.5.2 Flexibility in Healthcare PPPs

There are several levels of uncertainty in a healthcare PPP. Some are related to the context, such as the regulatory model, the evolution of macro-economic variables, or political guidelines. Others are associated with the supply side (the hospital) or the demand side (the population profile).

Figure 3.7 summarizes the main types of flexibility that can affect healthcare infrastructure. Among the several types of infrastructure, healthcare is most likely the most complex because of the technological uncertainty and particularly because of the uncertainty in the demand (both volume and disease patterns). While in transportation projects, the uncertainty of demand is essential, the volume (e.g., the number of passengers or number of vehicles) in healthcare is not the only demand; the evolution of the disease patterns and the medical treatments associated with them are also uncertain. This raises a number of relevant questions.

Looking at how countries have been addressing such problems, it is clear that the preferred model is aimed toward eliminating the risk behind demand by focusing the PPP contract just on the hospital infrastructure (e.g., the UK, Canada and Australia). Portugal and Spain are among the rare examples where clinical management was incorporated in the PPP projects (Cruz and Marques 2013d). In the Portuguese case, this model was adopted in the so-called "first wave" (four large hospitals, involving one tenth of the Portuguese population and two other facilities) and was later abandoned in favor of the "infrastructural model", such as in the UK.

Although more complex, the bundling of the clinical management with the infrastructure allows capturing important synergies because the hospital design and operation is intrinsically related to the clinical management. The authors believe that this is an excellent example for illustrating the value of the flexibility in a PPP. One of the main problems of the model's bundling infrastructure and clinical services is that the demand is highly uncertain, and the search for a "less incomplete" contract leads to an overspecification of the hospital infrastructure. Sooner or later, a mismatch will be inevitable and can lead to renegotiations and, therefore, heavy compensations paid to the concessionaire.

How are the possible candidates for flexibility identified?

What if the concessionaire had the managerial flexibility to decide how to allocate spaces and how to increase capacity to better accommodate the changing nature of demand?

If the concessionaire is responsible for ensuring future clinical services, no matter what they are, he will most likely adopt architectural and engineering solutions with the required flexibility to be adapted.

3.5.3 Case Study

3.5.3.1 Main Features

The selected case study is a real hospital. The PPP arrangement includes both the infrastructure and the clinical management. The main features of the project are presented in Table 3.5.

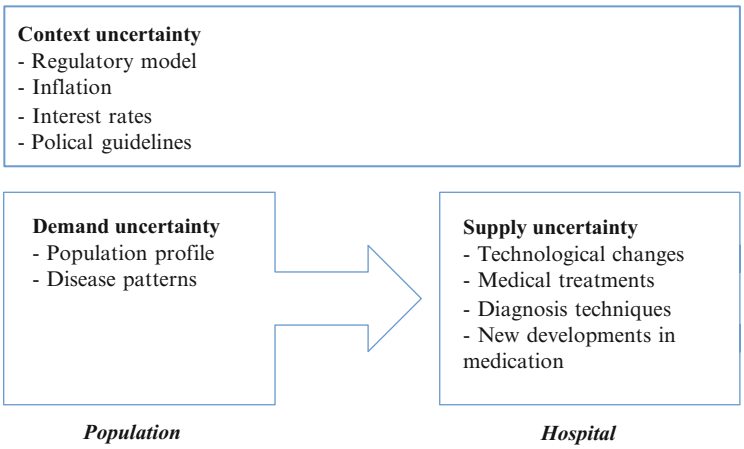

Fig. 3.7 Uncertainty in health PPP projects

3.5.3.2 Risk Sharing

The model assumes that the concessionaire will be responsible for all major risks, such as construction, design, operation, maintenance, financing, demand, performance, legal (fiscal) and regulatory. Some risks are shared, such as political and technological ones. The grantor will hold the risk of *force majeure*.

3.5.3.3 Financing Scheme

The financing scheme is based on demand. This means that the concessionaire will be paid on the basis of the treatments provided (number and type). Each medical treatment has a contractual established price, and the concessionaire remuneration will be the product between the price and the number of treatments. This value can have deductions because the contract management establishes some quality of service criteria (e.g., related to availability) which if the concessionaire does not meet them, can result in fines.

3.5.3.4 Option of Flexibility Considered

Because the concessionaire has the responsibility of jointly managing the infrastructure and the clinical services, the flexible option incorporated in the simulation gives the concessionaire the option to decide which production line to increase: either the ambulatory services or the inpatient treatments. Emergency services are a particular case. Considering that this is a public hospital within the NHS, these emergency services are mandatory and have to be dimensioned to accommodate all demand.

With ambulatory services and inpatient treatments, the concessionaire has the option to decide which service to expand based on the evolution of the demand. To allow for this flexibility, the concessionaire holds some commercial risk (demand). The remuneration model is based on a service provided basis, both in the inpatient regime and the ambulatory. The remuneration established for each service needs to

Table 3.5 Summary of the main features of the project

Brief description	Central hospital integrated in the national health service. The cost for patients is extremely low (compared with private facilities). It has differentiated services and an emergency unit
Initial capacity	12,000 inpatient
	80,000 ambulatory
Final maximum capacity	36,000 inpatient
	320,000 ambulatory

account for direct costs (medical treatments, staff, and equipment, just to name some examples) but also indirect costs related to the construction and maintenance of the infrastructure (hospital).

Neufville and Scholtes (2011) propose a three-step process to correctly assess and evaluate the chosen flexibility:

1. Evaluation of individual designs: for each design (in this example, the OBC and the flexible scenario), calculate the NPV of the project;
2. Multidimensional comparison of designs: the values of the scenarios are compared. This can be conducted from a multidimensional perspective, when more than one attribute is being considered. In this example, from a public sector perspective, the only dimension under analysis is the projects' NPVs; and
3. Validation by sensitivity analysis: considering that the future is uncertain, it is important to perform a sensitivity analysis to test the validity of the main conclusions. One scenario might seem better than the other but only under certain assumptions. Performing sensitivity tests increase the robustness of the decision making process.

3.5.4 Model Specifications

The model was updated from the model developed by Cruz and Marques (2013c) with a new case study and considering an American option with two variables: demand for inpatient (*D_inp*), and demand for ambulatory (*D_amb*). Figure 3.8 presents the quadrinomial tree.

The longer the contract, the more complex becomes the quadrinomial tree. For a 40-year contract, it gives rise to 4^{40} possible events. This is an extraordinarily large number. Our case study, in each node, only has two unknown variables, inpatient or ambulatory, and therefore, the quadrinomial tree becomes a binomial one (see Fig. 3.9).

For each generated scenario, a corresponding NPV needs to be calculated. Through the Monte Carlo sampling technique, the various scenarios are generated, and the respective NPVs are calculated.

The expected value of the option (ExpOptionValue) will be the difference between the expected NPV of the flexible scenario ($ExpNPV_{flexible}$) and the

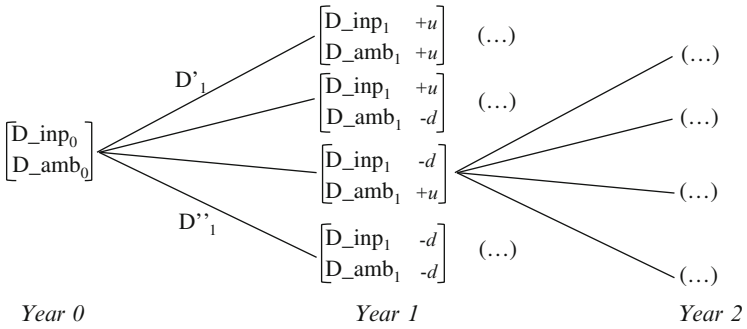

Fig. 3.8 Representation of the quadrinomial tree (Source: Adapted Cruz and Marques 2013c)

expected NPV of the inflexible scenario ($ExpNPV_{inflexible}$), according to formulae (3.7) (Cruz and Marques 2013c):

$$ExpOptionValue = ExpNPV_{inflexible} - ExpNPV_{flexible} \tag{3.7}$$

If the difference is positive, it means that the option has a positive value, meaning that the option should be incorporated into the project. If negative, it means that the option decreases the project's NPV and should not be included.

3.5.5 Assumptions

3.5.5.1 General Assumptions

All assumptions were made using real data. For example, for the construction costs and operating expenses, real data from a set of ten Portuguese hospitals were used to define them as accurately as possible. The model requires two variables to characterize demand: the annual average growth rate and the volatility. These values are usually defined taking into account the identifiable historical patterns. When this information is not available, it may be necessary to use other methodologies, i.e., experts' judgment.

Figure 3.10 presents the historical pattern for inpatient treatments. The data panel only covered 10 years. The average growth rate was estimated as 2.8 % with a volatility of 4.2 %. The proxy used for volatility was the standard deviation.

The same analysis was performed regarding ambulatory treatments, and the respective results for the average growth rate and the volatility were 3.0 % and 4.7 %. The average growth rate and the volatility will be used to create several scenarios of the binomial lattice. Table 3.6 presents the inputs for the binomial lattices.

The estimated costs for the new infrastructure took into account the historical values and real costs of other similar projects (Table 3.7).

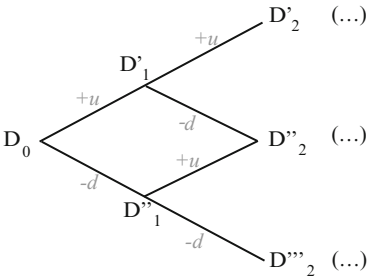

Fig. 3.9 Representation of the binomial lattice

The costs described in Table 3.7 include not only the construction costs (hospital, car parking facilities, etc.) but also "soft infrastructure" related costs, such as the medical equipment. In addition to these deterministic values, it is necessary to define the distribution function. As mentioned earlier, costs are often underestimated, and the distribution function should reflect that evidence.

In fact, as shown in Chap. 2, the historical data of costs are best fitted by a log normal distribution, confirming the initial hypothesis that it is very likely that the costs are higher than expected. The capacity increases were forced by the model to take place 2 years before the capacity is reached (at a 95 % threshold). The cost of equity, $k_{E,}$ is determined by the following formulae:

$$k_E = r_F + \beta_A(r_M - r_F) \tag{3.8}$$

where r_F is the risk-free return rate (considered 6.0 %, taking the Government Bonds as a proxy), β_A is the asset beta and is 0.6118 for this type of infrastructure (see more in Alexandre et al. 1999), and $(r_M - r_F)$ is the market risk premium, considered 6 % (using Damadorans' data base for Western Europe and North America). With these assumptions, the k_E obtained is equal to 9.67 %.

The choice of the discount rate can be problematic (see more in Chap. 2). Nevertheless, for this purpose, the discount rate was calculated based on the WACC formulae:

$$WACC = k_E \times \frac{E}{D+E} + k_D(1-t) \times \frac{D}{D*E} \tag{3.9}$$

where k_E is the cost of equity (calculated according to formulae 3.9), D is the debt, E is equity, k_D is the cost of debt (5 %) and t is the corporate tax (25 %). The ratio $D/(D + E)$ represents the capital structure leverage, i.e., the weight of the debt in the capital structure, considered to be 67 %, assuming that two third of the investment will be ensured by debt, and therefore, the weight of equity in the capital structure is 33 %.

The assumed contract duration is equal to the one currently being used in most PPP contracts – 30 years, even though the lifespan of a hospital is usually longer: 60–80 years. Although it was possible to consider a partial amortization of

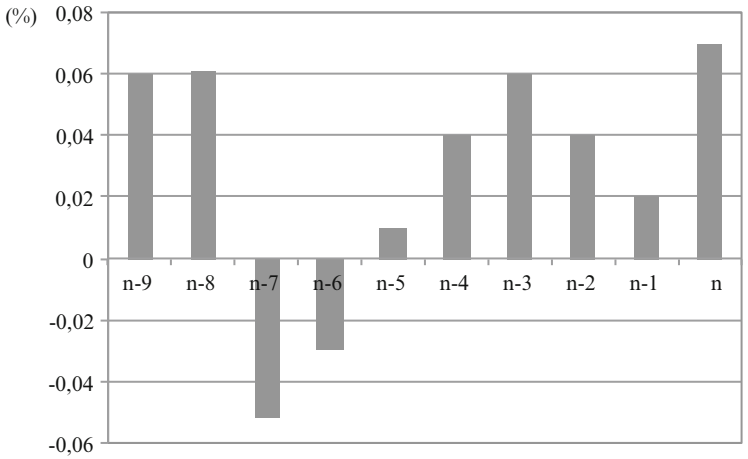

Fig. 3.10 Annual growth rate in patient treatments (10-year period)

investment, because this is not the current practice, the model assumed a full amortization in 30 years.

3.5.6 Scenario Modeling

As mentioned earlier, two alternative scenarios were modeled: an inflexible and a flexible scenario:

- Inflexible scenario: the capacity increases in each production line are pre-established according to the investment plan. However, there is not a pre-defined date to increase the capacity, but this should happen when the capacity is reached (at a 95 % level);
- Flexible scenario: the capacity in each production line will increase according to the demand requirements (the same 95 % level was assumed for the capacity limit).

3.5.7 Results

The stochastic modeling of the Monte Carlo simulation gives a probability (and frequency) distribution for the final NPV. A Monte Carlo simulation is a widely used technique to generate random values based on a priori distributions. It estimates several future possible paths for each one of the variables used. This ultimately results in a distribution function for the expected NPV.

In total, 10,000 simulations were computed, and for each simulation, the $NPV_{inflexible}$ and $NPV_{flexible}$ were calculated. The expected NPV for the inflexible scenario is 62.3 million Euros, while for the flexible scenario, it is 69.9 million

Table 3.6 Binomial lattice inputs

	Inpatient	Ambulatory
Inpatient demand (year 0)	8,976	73,804
Annual growth rate (ν)	2.7 %	3.1 %
Volatility (σ^2)	4.1 %	4.5 %
Increase factor (u)	1.25	1.19
Decrease factor (d)	0.80	0.84
Probability increase factor (p)	0.59	0.59
Probability decrease factor (1-p)	0.41	0.41

Table 3.7 Cost assumptions

	Inpatient	Ambulatory
Initial investment	40 M€	17 M€
Initial capacity (treatments)	12,000	80,000
Final investment	180 M€	65 M€
Final capacity (treatments)	36,000	320,000

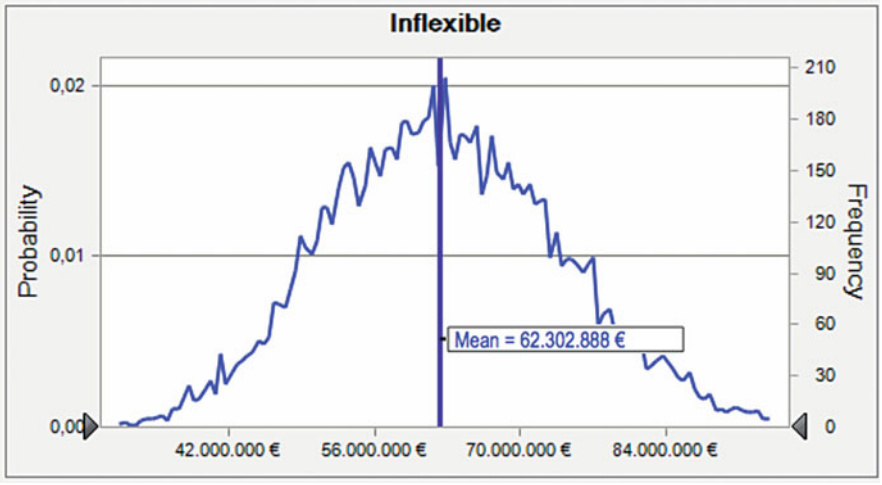

Fig. 3.11 Monte Carlo simulation for the inflexible scenario (probability and frequency distribution)

Euros. These results confirm the initial hypothesis that the flexible scenario can add value to the PPP. Figures 3.11, 3.12, 3.13, 3.14, 3.15 and 3.16 present the results.

When interpreting the results, one should consider that because we are dealing with probability distributions, it is important to take into account metrics such as the mean NPV or the expected values at probabilities of 10 % or 90 %. In all metrics, the flexible scenario seems the best alternative. The average NPV for the flexible scenario is 68.8 M€, while for the inflexible scenario, it is 62.3 M€. This represents

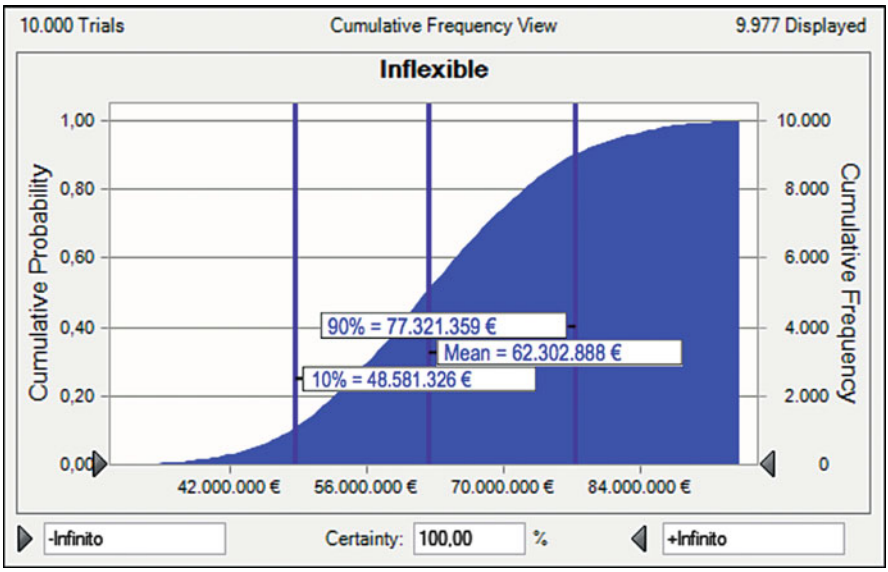

Fig. 3.12 Monte Carlo simulation for the inflexible scenario (probability and frequency accumulated distribution)

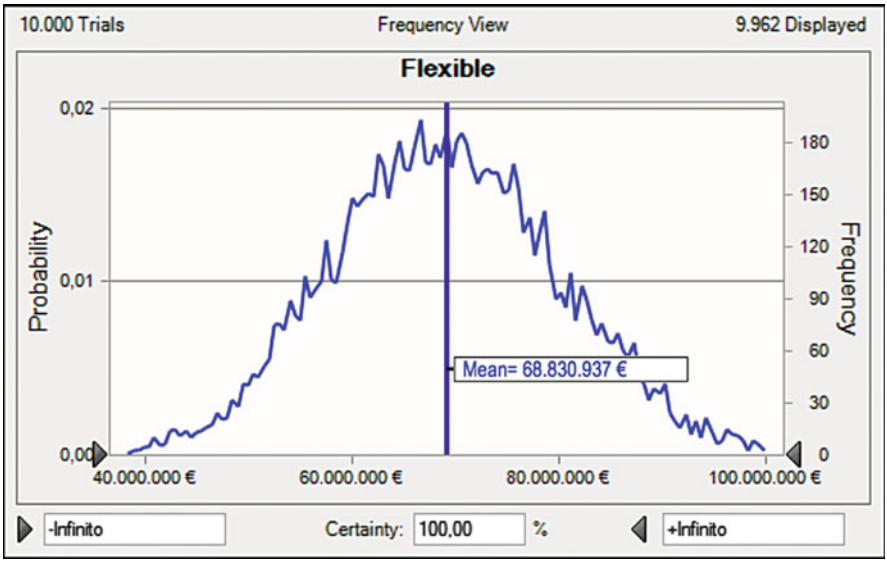

Fig. 3.13 Monte Carlo simulation for the flexible scenario (probability and frequency distribution)

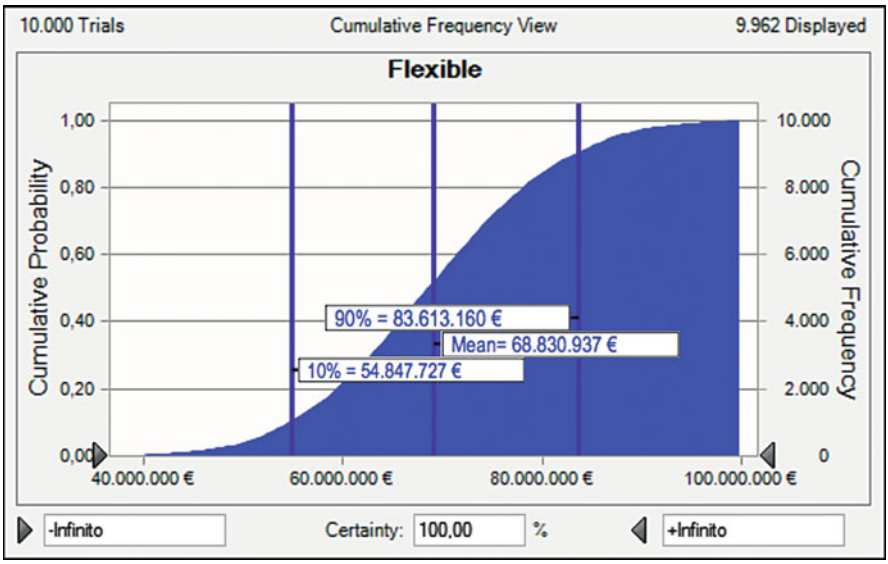

Fig. 3.14 Monte Carlo simulation for the flexible scenario (probability and frequency accumulated distribution)

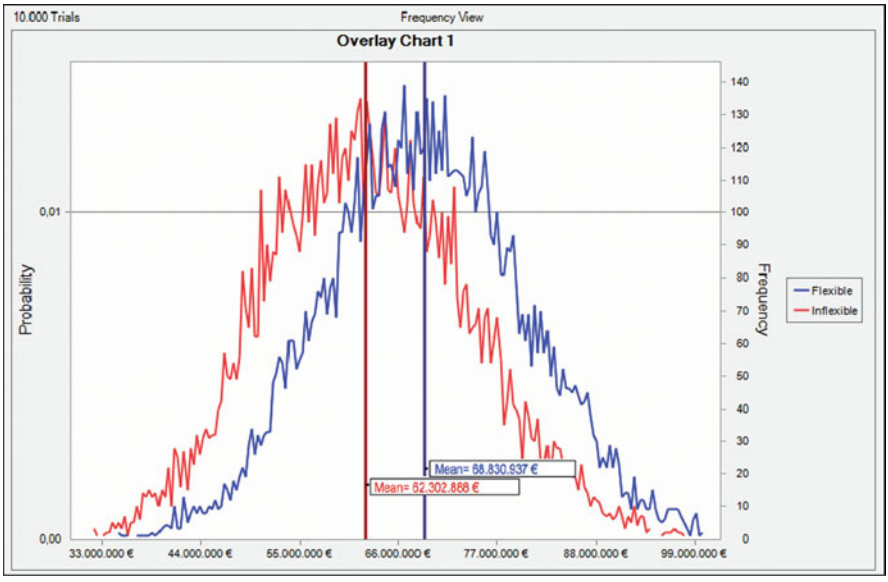

Fig. 3.15 Overlay of both scenarios (frequency and probability distributions)

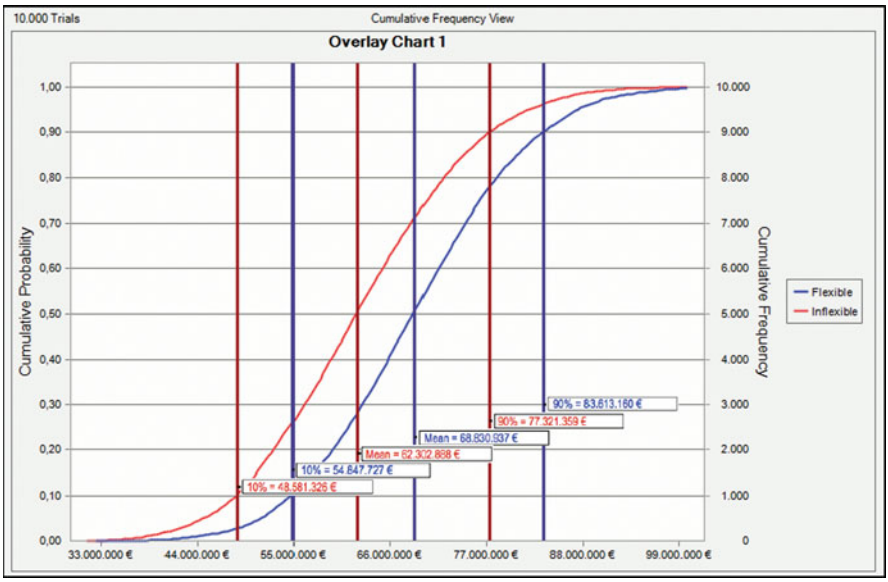

Fig. 3.16 Overlay of both scenarios (frequency and probability accumulated distributions)

an added value of 6.5 M€ (10.4 % increase) brought by the incorporation of the managerial flexibility.

It is important to remember that this gain is only obtained by deciding which production line to increase. If the inflexible scenario also considers a fixed investment plan with pre-established dates for each capacity increase, the difference will be much higher.

When looking at the value at a risk of 10 %, the inflexible scenario is higher by 13 %, which means that it deals better with the worst-case scenario. However, considering the value at a risk of 90 %, the difference decreases to 8.1 %. In addition to generally increasing the mean NPV (Neufville and Scholtes 2011), flexibility significantly improves the performance of the project when facing pessimistic scenarios, which, for PPP purposes, means lower demand scenarios.

3.6 Main Findings

The results confirm the hypothesis that allowing for a greater managerial flexibility can increase the project's NPV. This is something that one would empirically expect. The project is more valuable when investment decisions are postponed to the moment when more information is made available. This is a mechanism to address uncertainty. In more unstable and uncertain environments, the option value will increase because more information is available over time. Theoretically, if the volatility is zero, the option does not have any value. In cases where incorporating an option can add costs (e.g., preparing the deck of a bridge for a future third lane),

it can in fact be negative, assuming that there is no uncertainty. This assumption is fairly unreasonable, particularly in the infrastructure PPP sector. Nevertheless, it is always necessary to compare the NPV of the project with a flexible design to that of the project without a flexible design because this is the only alternative to calculate the option value.

PPP arrangements are becoming the first choice of governments to deliver large and complex infrastructure. To effectively provide VfM, it is necessary to allocate risks to the private partner. The uncertainty surrounding these projects is an obstacle to risk transfer since, to cope with volatility, private partners require a higher risk premium, increasing the cost of the project. To address this fact, governments retain much of the risk, writing comprehensive contracts and compensating the private sector when reality behaves differently than expected. These comprehensive contracts restrict the degrees of freedom of the concessionaire, particularly those concerning investment decisions.

Managerial flexibility options imbedded in the infrastructure might create economic value. In projects subjected to high levels of uncertainty and involving large sunk investments, the value of future information is extremely high. Because that information is unknown by decision makers in the present, the possibility of deciding when that information is unveiled is worthy of consideration. The case study presented supports the thesis that a higher economic value can be expected when planning investments according to how demand unveils in the future.

This surplus, as defined, is captured by the concessionaire (the private partner), but a share of the profits might revert to the public sector (the grantor) under different configurations: decreasing annual rents, up-front payment, annual sharing of excess revenues, etc. The mechanism by which this value is shared is crucial because the private sector share must be enough to induce an effective managerial approach to fully extract value from the imbedded flexibility.

However, there are relevant trade-offs to consider. Managerial flexibility requires long term commitments, which are not compatible with a "rebidding strategy". To allow for the benefits of competitive behavior, establishing short-duration contracts significantly reduces, or even eliminates, the benefits of managerial flexibility and vertical bundling synergies. The benefits of this vertical integration can be higher in the case of more complex services. For example, in the case of the light rail system, there are not obvious and impactful synergies from vertical integration because there is not much flexibility to explore. As flexible designs gain momentum among academia, the analysis of this trade-off remains one of the most relevant subjects in this area and a promising field of research in the future.

Contract Management

4

4.1 Introduction

Contract management might be defined as the set of obligations defined in a contract that both sides (parties) should comply with. It is also the means to achieve their aspirations and expectations with regard to the full fulfillment of the objectives of the supply/provision of the infrastructure/building or service. The contract management phase is of great importance because it is mainly at this stage of execution of the contract (e.g., provision of infrastructure) that there is interaction with the user or customer and when everything that has previously been planned and designed gains shape. It is at this stage that the project is completed.

Most of the problems and pitfalls are a result of, or are aggravated due to, contract mismanagement. In some countries/regions, such as Australia, Canada or the UK, detailed guides and very clear rules are established for contract management. However, in others (e.g., Portugal or Spain), there are no procedures or guidelines, and all the details of this major activity are usually found in the body of the contract. As the contract is incomplete and it is unable to regulate everything, most of the principles and procedures of contract management are postponed to the stage of implementation of the contract. This means that they will not be defined and that contract management performed by the public partner is almost non-existent or very unsteady, being limited to basic activities (e.g., payments and complaints). This situation is even more serious because in these countries, in general, public administration and the justice system do not work well. For example, Portugal has more than 20 years of PPP projects and is one of the most active countries in the world in this regard (for better or for worse), but no sanction has ever been applied in any contract in any sector until now (2013), despite some attempts that have failed in the process of appeal to courts or that have been prescribed there.

Although the contract management process analyzed in this chapter follows a procurement model under a PPP scheme, most of the guiding principles of contract management remain valid for conventional public works. As noted in Table 4.1,

C.O. Cruz and R.C. Marques, *Infrastructure Public-Private Partnerships*,
DOI 10.1007/978-3-642-36910-0_4,

Table 4.1 Contract management in conventional public works and PPP projects

Focus:	Project	PPP
Preparation (*tender*)	Design (*inputs*)	Objectives (*outputs*)
Implementation (contract management)	Work	Contract

while in public works, contract management corresponds to the management of the work, and in the case of a PPP arrangement, it includes not only the management of the work but also the operation and maintenance of the infrastructure and/or public service.

Contract management has been one of the Achilles' heels of many public projects (Marques and Berg 2010). In particular, the costs and deadlines in the contract stage related to the construction works have often been largely overcome, and in PPP projects, systematic renegotiations (see Chap. 5) have taken place in a non-competitive environment with the prevalence of asymmetric information, penalizing the public interest by putting the biggest burden on the state and by changing the risk matrix (Cruz and Marques 2013e, f). In a life-cycle perspective, although it might seem the opposite of what is expected, in projects conducted using conventional public procurement models (public works), the situation is sometimes more severe because, in general, the operation and management phase is not established (in a contract), so public authorities do not prepare this phase adequately and fail to evaluate in advance the financial and management impacts, causing many of the public buildings/facilities and other infrastructure to be in poor condition or inoperative. In the case of PPP arrangements, requirements and procedures for contract management are seldom laid down in the tender documents, and public entities usually are not endowed with resources and skills to make an appropriate contract management (Marques and Berg 2011a). Furthermore, there are also cultural and operational issues in some countries (e.g., the justice system) that make it difficult to carry out an effective contract management, such as the effectiveness in the application of fines, as mentioned before (Cruz and Marques 2012b).

The effective contract management should be prepared as soon as possible, in particular in the procurement phase, to understand the project as a whole in the various phases of the life-cycle. Although contract management formally only begins with the signing of the contract, it is at the stage of preparation of the tender documents that the strategy for contract management must be outlined, including anticipating the obligations of public and private parties in the implementation of the project. Figure 4.1 illustrates the beginning phase of contract management. The missions of contract management vary according to the life-cycle phase, although they try to achieve the same objectives. For example, performance monitoring is different if the phase of the project corresponds to the construction or to the operation and maintenance of the service or infrastructure. While in the first phase there is monitoring and control of the construction work (if major objectives are being fulfilled) and of the quality of the management and supervision, in the second phase the private partner performance is controlled by the operation,

Fig. 4.1 Beginning of contract management (Source: Adapted Dombkins 2012)

maintenance and the fulfillment of contractual arrangements. It is also important to obtain feedback from users/customers.

This chapter on contract management consists of seven parts, starting with this overview about contract management and its importance for the success of any project. In particular, this part discusses the relevance of contract management and presents its main features and objectives. Furthermore, a brief comparison between the different models of public procurement and between the conventional public works and PPP arrangements is conducted. In a second part of this chapter, the functions of contract management are discussed, particularly those relating to relationship management, operational management and administrative management. This three-dimensional nature of contract management is discussed and analyzed under a theoretical and methodological point of view. In the third part, the main aspects and requirements necessary for an adequate contract management and its most relevant activities are presented and discussed. A part of them, which is directly related to the functions of the contract management team, comprises four fundamental aspects for the success of the development of contract management, including planning, collection and analysis of information, contract administration, contract governance and its continuous review. The main activities to be developed (the ones with a more active nature between the contract management team and the concessionaire) include the monitoring and reporting of performance, relationship management, the resolution of conflicts and problems, information and knowledge management, event management and contingency planning. In the fifth part, some empirical case studies illustrating the current state of affairs of contract management in PPP projects are examined. A sixth part includes an analysis of the main "sins" found in contract management. Finally, the concluding remarks and major findings on contract management will be presented.

4.2 Characteristics and Objectives

Contract management is a multi-disciplinary activity, covering technical, financial and legal aspects so that it consumes relevant resources. The existence of transversal structures that allow for the management of several infrastructure contracts across different sectors can be an effective option (e.g., Partnerships Victoria in Australia or Infrastructure Ontario in Canada). Moreover, before the tender for the project is launched, it must be assured that there are adequate financial resources,

including those that allow hiring specialized staff with experience in relationship management with public and private partners. Particularly, at the early stages (construction and certification/commissioning), there is a high consumption of resources. In this context, it is also important that public authorities have the capability to ensure the continuity of the main staff they hired and have a specific and growing know-how (learning curve) as the project moves forward. The continuity of the contract management team associated with knowledge management and relationship management of the partnership are essential aspects to contract management (DFA 2006).

Contract management should, however, be autonomous and independent from the technical monitoring of the project, focusing on the strict compliance of the contract. The contract manager should avoid questioning, adapting or correcting the contract (EPEC 2010). On the contrary, he should always bear in mind that the contract represents a balance that has been achieved after a careful tender process, sometimes resulting from a renegotiation process. Any simplification or adaptation of contractual rules by the contract management can affect that balance. Furthermore, changing the initial contract in certain countries (that follow the continental administrative law) is not allowed (e.g., France or Italy). In short, the contract manager should meet the letter and the spirit of the contract and avoid circumstantial readings. This does not mean that contracts are immutable. Actually, PPP contracts, being long term (and incomplete) contracts by definition, are subject to change and periodic reviews. However, there is a right place to address such changes, and the role of the contract manager is not to trigger them (at least without reasonable grounds to do so). A very important issue is that the project schedule is not controlled by the contract management and that the project moves forward regardless of the possible inaction of the contract manager (the state).

Two key aspects in contract management concern the risk management and the development of the management plan of the contracts (Chaponda 2007). The risk management during contract accomplishment must assure adequate risk allocation, which provides the VfM of the project (Marques and Berg 2011a), bearing in mind that the initial risk matrix (of the public tender) cannot be altered in favor of the private partner. The development of the management plan of the contract, which is specified in the so-called Contract Administration Manual, identifies the roles and responsibilities of the parties and the necessary resources. It provides a guideline of the capacity in which the public partner has to ensure contract compliance. This strategic document is a guide for both parties (public and private entities) relative to the accomplishment of the different activities associated with the development of the PPP project in the phase of the execution of the contract.

Note that the need for contract management arises not only from the impossibility of writing perfect and complete contracts but also from the inefficiency of the partners (public and private). Therefore, there is a group of matters (associated with attitudes and behaviors) that despite being in compliance with the letter of the contract, should not and cannot be defined there. The appropriate place to address these issues should be the Contract Administration Manual. This document, which should be approved and enter into force when the PPP contract is signed (to start the construction/development of the project), as highlighted above, should start at the

same time as the tender documents and should be updated regularly during the project life-cycle to try to avoid conflicts between the parties. However, other documents can be signed by the parties to bind, for example, the relationship between partners (e.g., relationship agreement).

There are several objectives of the contract management of PPP projects. In particular, in a systematic way, the activity of contract management aims to assure the compliance with the contractual clauses and defend their stability and, consequently, to also assure the fulfillment of the project objectives and the safeguarding of public interest. Contract management also aims to keep a constructive and healthy relationship with the private partner, protect the position of the public partner, defend the sustainability of the partnership and safeguard the rights of third parties. As mentioned, an adequate risk management during contract execution, according to what has been established in the initial risk matrix, is a necessary condition for the achievement of these objectives.

Finally, it should be highlighted that contract management does not intend to replace the possible existence of a regulator and contract regulation. If the contract manager is naturally biased for the benefit of the public partner, the regulator should act as a referee, and although its mission is to defend public interest, it should be neutral defending what is right without 'favoring' the public or the private partners. This reality is particularly relevant in the renegotiation stage, where contract management is quite important to avoid renegotiations or to endow the public partner with more information and put it in a better position to bargain with the private sector (reducing the usual asymmetric information). Conversely, the regulator (when it exists) is essential in the renegotiation process itself, being a referee and a guarantee that public interest is protected by fostering transparence, participation and fairness and by assuring the accountability and right to issue opinions of the partners.

4.3 The Three-Dimensional Contract Management

Contract management involves three major domains that complement and interact with each other, although they have distinct natures. The three domains are operational management, relationship management and administrative management. Figure 4.2 presents these three dimensions of contract management as well as the various activities and aspects of their content.

Operational management aims to ensure risk management in accordance with the contract as well as to ensure adequate performance according to the rules specified in the contract. In particular, risk management and the monitoring of the performance and of the results by the private partner through KPI assume a prominent role. Furthermore, operational management includes also other important issues such as those related to the management of interfaces (e.g., in a metro system, where the infrastructure corresponds to one contract and the train operation to another one, and both are managed by distinct companies), the management of quality or the continuous improvement of the infrastructure and/or service.

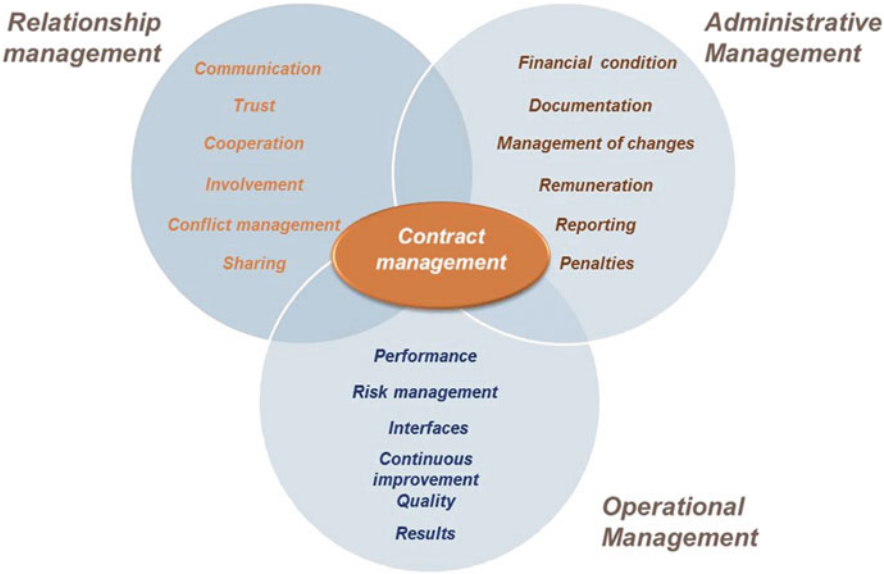

Fig. 4.2 Areas of contract management (Source: Adapted PPP Unit 2004)

Relationship management aims at ensuring the management of all aspects related to the structure of the public authority with a spirit of cooperation and partnership and with accountability within the framework of the service provision to safeguard its efficient performance. It involves, among others, the aspects associated with trust, participation, cooperation, sharing, communication and conflict management. It is a very important and complex domain because of the contradictory interests that sometimes exist between the parties, the limits of that relationship and of the possibility of capture, and the difficulty of anticipating and solving conflicts (Edkins and Smyth 2006). Inevitably, in long and imperfect contracts, there is always a great deal of negotiation throughout the duration of the contract, which requires the contract manager to have well-developed skills in the fields of relationship and communication. It is important to bear in mind that a misfit relationship or a careless communication can affect the risk matrix, and sometimes there are problems associated with the existence of multiple stakeholders (mainly on the side of the public partner). If the relationship between these parties is not good, the effective contract management may be affected. It should be noted that it is unrealistic to think that one can overcome this phenomenon of multiple interlocutors; the best one can do is to promote their harmony.

Finally, administrative management involves the management of all flows relating to the administrative processes required to manage all process and documentation procedures specified in the contract. It covers aspects related to reporting, event management, document management, penalties and payments (or rent collection) by the private partner. Information systems might play a very important role here.

These areas of contract management, which correspond to contract management functions, comprise a set of activities and aspects that were grouped into key elements that will be examined in the next chapter.

4.4 Key-Elements of Contract Management

4.4.1 Conceptual Aspects of Contract Management

Bearing in mind good international practices, particularly the experience in Australia (e.g., Infrastructure Victoria, among others), the UK (e.g., NAO 2008, among others), Canada (e.g., Infrastructure Ontario, among others) and other countries used as references, as well as the academic and empirical experience of the authors, the key elements for the development of contract management by the public partner will be presented next, including the main activities that should be conducted in this scope. Figure 4.3 presents the conceptual model for contract management of PPP projects.

The inside orbit of Fig. 4.3 includes the main requirements for suitable contract management that comprise information collection and analysis, contract administration, contract governance and its continuous review. Its incorrect handling by the public partner will put in danger the development of key activities of contract management and, consequently, its objectives and those of the PPP project. These aspects are instrumental and mainly related to the internal working of contract management, even though they have consequences for the concessionaire.

In the outside orbit of Fig. 4.3, there are the main activities to be developed by contract management. They comprise performance monitoring and reporting, relationship management and conflict, problem resolution, information and knowledge management, event management and the planning of contingencies. Not planning these activities and not considering them in the project development in an appropriate way will jeopardize the objectives for which it has been designed.

As we will see in the next chapter, most of these activities were not adequately predicted in the design and development of the PPP projects in several countries, and this led to added costs and damage to public interest (through renegotiations in the PPP arrangement, for example, due to extra work in the planning of investments) and the yielding of an infrastructure or the provision of a service with a lower quality than expected.

Next, the key-elements of contract management of PPP projects are described and analyzed.

4.4.2 Internal Aspects of Contract Management

4.4.2.1 Analysis and Collection of Information

The strategy of contract management and the corresponding activities should be planned *ab initio*, requiring information collection and its analysis with the purpose

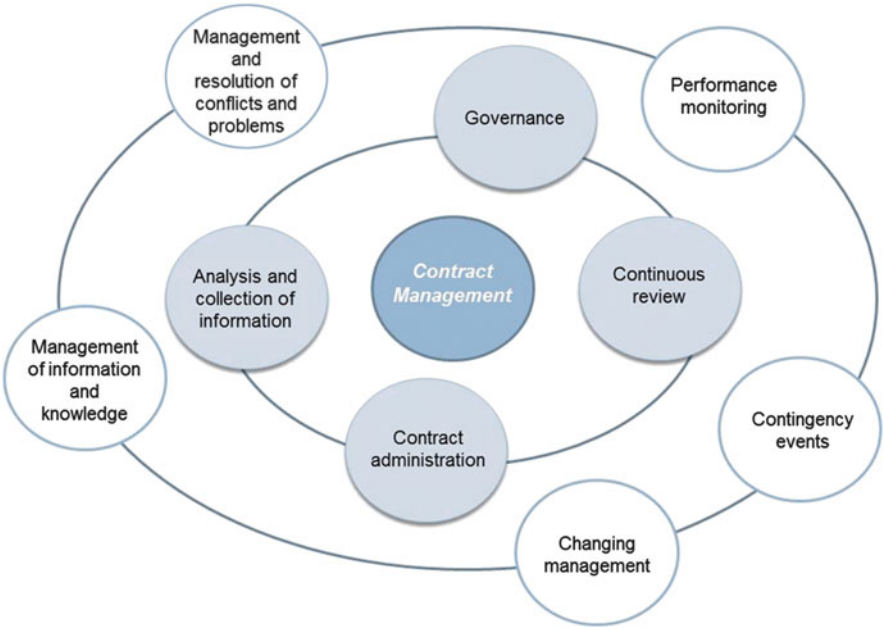

Fig. 4.3 Key aspects and key activities of contract management

of improving and fine tuning the contract management plan and the identification, management and better understanding of the risks involved by the public partner.

In this scope, the contract management team should understand all the contexts (legal, institutional and commercial) of the contract and identify all the risks of the project and their updates over time, as well as the probability of the risks and the consequences associated with them if they take place, the mitigation measures, the economic cost and the associated risk premium, the interdependences between risks and the evolution of the risk profile over time (NAO 2008).

The contract management team should also focus on the relevant information for the objectives of contract management in PPP projects, bearing in mind that an excess of information can be as harmful as a lack of information.

4.4.2.2 Contract Administration

The contract management team prepares the Contract Administration Manual. This document should answer the following questions. What are the tasks to be developed? Who develops them? When should they be developed? What is the government's role? What are the consequences of noncompliance by the private or the public partner in the project, and what is the best way to deal with them?

An effective contract administration enables the public partner to anticipate and mitigate the risks at any time of the project life-cycle, assuring that the project objectives are attained.

4.4.2.3 Governance

An appropriate contract management requires the good principles of governance to be fulfilled by the public partner in its interactions with the private partner or with other stakeholders.

Contract management should be ruled by accountability principles, transparence, participation and equity. Some good practices include public hearings in the parliament, public access to documentation and its compulsory publicizing, jurisdiction of the ombudsman, confidentiality when it is appropriate, a moral and ethical attitude by the public partner when it relates to the private entity, subjection to the Court of Auditors and the penalization of irregularities and inadequate practices concerning the faulty parties. In this way, the public partner performs self-regulation and commits itself to comply with laws, regulations and government policies.

4.4.2.4 Continuous Revision

The ongoing review of contract management procedures ensures that the variation and adaptation throughout the life of the contract and the knowledge gained through time in the project are retained and disseminated. This can include differences in expectations and predictions of the parties that can be due to the occurrence of events or contingencies and changes in the external environment in which the project operates. As mentioned, these changes cannot alter the contents of the contract in a way that violates the public tender rules.

4.4.3 Main Activities of Contract Management

4.4.3.1 Monitoring and Performance Reporting

The control and supervision of performance provide important information that enables the control and development of actions with the aim of preventing risks from happening.

The public partner understands the environment of the project and checks if its objectives in the partnership are being attained. Therefore, it is important that performance measures are connected to the strategic objectives of the partnership.

The performance measures also allow for a better understanding of the operational environment of the private partner and its weakness and strengths, including the financial and operational performance. The public partner analyzes the performance and quality of service provided by the private partner considering the KPI or other metrics and the specification of the outputs defined.

The measures that should be compared with reference values, and even be weighted, are not exempt from difficulties (Robinson and Scott 2009). Therefore, they must be pragmatically defined, both in number and in content, taking into account the necessary and desirable resources for their determination (e.g., the availability in a motorway lane is very difficult to control, but it is the most adopted payment scheme in shadow tolls). The private partner should measure and analyze its performance systematically and inform the public partner, while the public

partner should mainly audit, inspect periodically and promote control meetings with the private partner. It can also be a good option to perform compulsorily quality of service inquiries by independent entities.

The use of benchmarking and incentive mechanisms, such as penalties for a bad performance (e.g., deductions in payments, penalties, sequestration, early termination or bailout) or awards for excellence, performance-based payments, quality certifications and the adoption of codes and programs of good management and maintenance practices are some of the aspects to consider in project performance reporting and monitoring.

The management of faults and the resulting penalties have particular relevance in this context. These penalties, which can be imposed in various ways (from payment deductions to contract termination), often lead to problems and conflicts with the private partner.

Figure 4.4 presents a model for the performance monitoring of PPP projects. A mixed approach to performance monitoring is proposed. It includes a self-report and evaluation by the private partner, a joint review by both parts (e.g., periodical meetings), the control and monitoring by the contract management team and periodical feedback of the users/customers.

4.4.3.2 Relationship Management and the Resolution of Conflicts and Problems

Given the long term nature of partnership contracts, it is fundamental to establish a good relationship between the parties, which will make it possible to anticipate events that generate risks, to be more effective in their treatment when they occur and to address disputes and problems that may arise over time.

Good communication and a strong relationship are essential, and consequently, there should be a mutual assessment of objectives, strategies and viewpoints (coinciding vision for the project) and of the availability of collaboration and team work. Communication between parties should be open and clear at different levels, especially at a senior level. Furthermore, a degree of recognition and confidence in the competence of the parties and a constructive attitude for the project where neither guilt nor individual confrontation should take place when there are problems is also very important. The relationship between the parties must be evaluated periodically (Infrastructure Partnership 2002). It should be noted, however, that an excessively 'good' relationship can be harmful and permissive and lead to the capture of the contract management team (Marques 2005).

Contracts for PPP projects usually have clauses for the resolution of conflicts. However, their procedures are not always sufficiently clear and detailed, and because of external factors (e.g., efficiency of the justice system), they often turn out to be ineffective. In addition, contracts usually only foresee extreme situations (e.g., arbitration) that can be avoided with an effective contract management, especially through a friendly relationship between the parties and practices that prevent their existence, as well as with the adoption of less formal mechanisms for conflict measuring and resolution. For example, holding periodic discussions on the most sensitive matters or establishing expert or stakeholder panels might be good

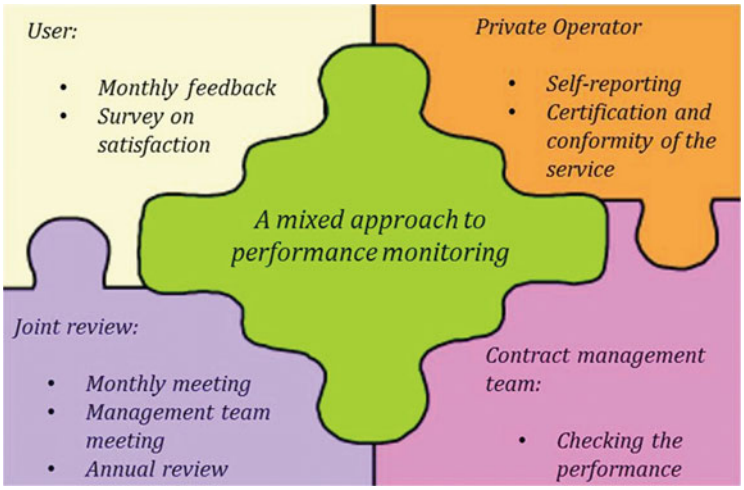

Fig. 4.4 Performance monitoring (Source: Adapted Efficient Unit 2007)

options (El-Gohary et al. 2006). It is crucial that the problems are internally solved, avoiding their escalation to levels that are difficult to reverse (Quick 2003).

4.4.3.3 Information and Knowledge Management

The proper management of information and knowledge allows quick and easy access to the project, enabling the public partner to fulfill the obligations regarding storage, disclosure and the protection of information. This includes the task of maintaining a database of updated records, disclosure obligations in relation to the administrative and public aspects of the contract and the principles of confidentiality to comply with intellectual property legislation. Furthermore, as the projects correspond to long term contracts, the management of information and knowledge allows those who work on the project to know its history, and it also enables external learning and the exchange of information between projects and stakeholders (e.g., benchmarking application). Finally, it allows an even greater oversight and involvement of stakeholders in relation to the progress and performance of the project. An option that could lead to good results is the existence of a 'diary' of the project where all facts and events would be recorded throughout its life-cycle.

4.4.3.4 Event Management

An effective change management ensures that events are run smoothly without creating unnecessary risks or acceptance by the public partner of undesirable risks. The changes can not alter the original risk matrix so that the VfM of the project is not jeopardized. Therefore, the events should be identified, documented and adequately established (with defined and clear procedures). It is important that the contract have some flexibility to be able to include win-win changes (Infrastructure Partnership 2002) without changing the letter and spirit of the contract (NHS 2001). All those events that give rise to the restoring of the financial balance of the contract

are especially relevant, which, as mentioned, is one of the biggest problems of PPP contracts (Cruz and Marques 2013b, g). Therefore, it is essential that the principles of transparency, participation, competition (if there are any new works) and intergenerational solidarity are fulfilled.

4.4.3.5 Contingency Planning

An effective contingency plan ensures that the government has the capacity to react to unplanned events, including *force majeure* events, not under the responsibility of the private partners, manage their impact and ensure the VfM. In this context (project management), contingency plans should be drawn up and emergencies identified, and their financial and operational consequences and the role of insurance must be maximized in this area. These plans must be considered in the contract and be accessible, understandable and easy-to-use by the contract management team. As most of the infrastructure and public services are essential to society, the role of different stakeholders (mainly that of the concessionaire and the government) is very relevant when extreme events take place.

4.5 Case-Studies

4.5.1 Overview

This chapter presents three empirical case studies of contract management in PPP projects: a prison facility in Australia, a bridge in Canada and a hospital in Portugal. The two first examples correspond to projects where there is a well organized contract management structure, while in the third case, the project is administered ad-hoc, taking into account only the clauses of the contract. Unfortunately, the latter situation is the one most often found in worldwide PPP projects, and therefore, it is very important to understand and examine the typical mistakes and problems in this scenario. Finally, a section is dedicated to the most common 'sins' in the contract management of PPP arrangements.

4.5.2 Ararat Prison Project (Australia)

This project is an expansion of an existing prison. The 416 million Dollars project, involves a 350-bed increase. It was awarded by the Minister for Corrections on behalf of the Crown in right of the State of Victoria (State) to Aegis Correctional Partnership Pty Ltd, and expires in 2037. The project is part of the Victoria's correctional system upgrade, in order to meet the expected future demand (prisoners). The contract involves the design, build, finance and maintenance of the facility. All custodial services will keep being provided directly by the Department of Justice. For this contract, the concessionaire will receive quarterly payments, subjected to performance standards. Table 4.2 will present the main features of this contract regarding contract management.

Table 4.2 Key elements of the contract management of the Ararat Prison (Australia)

Key-elements	Contract clauses	Summary of the information
Analysis and collection of information	Article 55 – Information and audits	It entitles the concessionaire with the responsibility of providing to the grantor:
		Economic and financial information, such as, annual accounts, management accounts (statement of financial performance, cash-flow statement and financial position, among others);
		Business plan (no later than 30 April);
		Additional information
		The concessionaire should ensure that the information follows the proper accounting principles, as well maintain adequate financial records. The accounts should be audited and the concessionaire may have to deliver, upon request, to the grantor, a certificate of non-default
		The grantor can appoint a financial auditor to audit the concessionaires' accounts
	Clause 56.1 – General	The concessionaire should "duly and punctually comply" with the requirements regarding project documents and finance documents
	Schedule 18 – Services specification	It establishes the conditions to update and manage the performance data (e.g. all performance data should be accurate, complete and correct within 24 hour of collection)
	Clause 56.5 – Appointment of principal officers	For the purpose of complying with the Freedom of Information Act, both parties agree that the Office Holder should provide all requested information
		The concessionaire must also appoint a "principal officer" for the Ombudsman Act
Contract administration	Article 3 – Independent Reviewer	It establishes the criteria and process for selecting the Independent Reviewer, as well as his obligations. The main obligation is the impartiality, meaning that it should not act as a grantor neither as a concessionaire's representative
	Article 4 – State and project co delegates	It establishes the function of the Project Director that represents the grantor (in this case the state), as its delegate to

(continued)

Table 4.2 (continued)

Key-elements	Contract clauses	Summary of the information
		administer the project. Therefore, the grantor is responsible for his appointment
		The grantor will also appoint a Contract Administrator that represents the grantor (in this case the state), as its delegate to administer the contract
		The concessionaire also designates a representative that will act as a spokesperson and statesperson
		The concessionaire should also designate a Development Coordinator, during the design and construction phase
	Article 11 – Project and site management	The grantor and the concessionaire should appoint a Project Control Group within 30 days after the contract is signed. The Project Director chairs this group, and its functions are essentially to advise and consult, since its decisions are binding to neither party. The group will meet in a monthly basis, no later than five business days after the Project Director receives the monthly report
	Article 31 – Payments for services	It provides guidelines for the payments to be made along the duration of the contract
		It also specifies the deductions for defaults, particularly regarding non-compliance with service specifications, prisoner escapes and false fire alarms
	Article 32 – Modifications	The concessionaire can ask for a modification at any time upon notification of the grantor
		The same way, the grantor can also claim for a modification. If there is not an agreement on the price for the modification, the dispute can be resolved by an independent expert
	Article 46 – Defaults, major defaults and default termination events	In case of default by the concessionaire, he should be notified of the default (default notice), and asked to solve the problem within 20 business days. The concessionaire can submit a draft cure plan to the grantor, and both parties should meet within five business days after the submission of the plan. This plan includes a cure period, which can be extended, by request of the concessionaire, no later than five

(continued)

Table 4.2 (continued)

Key-elements	Contract clauses	Summary of the information
		business days before the end of the period. If the concessionaire fails to solve the default, the state can take one of several actions, which may include, among others, contract termination or an appropriate court action
	Article 47 – State's rights to cure defaults	It establishes the grantor's right to intervene and solve any default at any time. If the grantor exercises its rights, the payments to the concessionaire should be deducted from the costs not incurred by the concessionaire due the grantor's intervention
	Article 49 – Final refurbishment works	The grantor can require a project review in order to assess the conditions and, eventually, require the concessionaire to perform refurbishment works in the last years of the contract. This review should be made by an independent reviewer appointed by mutual agreement of both parties. If there is not an agreement between the parties, the independent reviewer should be appointed by the contract administrator. His role is to determine the actions that should be taken in order to guarantee that the facilities are according to the specifications, and determine whether additional final refurbishment works are necessary
	Clause 62.5 – Amendment	Any amendment to the service specification has to be made by mutual agreement of the parties
	Schedule 18 – Services specification	It provides a list of specifications regarding the service: performance assessment, failure levels, response and rectification, response times and rectification times, maintenance event response time and temporary fixes
Governance	Article 51 – Senior negotiations	It establishes that any dispute should first be solved within a meeting between the senior managers that should try, in good faith, to resolve the dispute
	Article 58 – Probity events and investigations	Either party should notify the other if it becomes aware of any probity event. After the notification, both parties should meet, within 3 business days to discuss future actions. In case of no agreement, the grantor can notify the

(continued)

Table 4.2 (continued)

Key-elements	Contract clauses	Summary of the information
		concessionaire to take the proper action. The grantor can also request the concessionaire to conduct a probity investigation
Continuous revision	Schedule 18 – Services specifications	It establishes the obligation of the concessionaire to improve the KPIs and the performance monitoring program, in order to incorporate changes and identify flaws along the contract. These updates are subjected to review by the grantor
Monitoring and performance reporting	Clause 15.5 – Monitoring of design performance	The concessionaire must provide the Project Director the opportunity to comment all design documentation and the design performance
	Schedule 18 – Services provision	The concessionaire is responsible for developing a performance monitoring program, which should be reviewed, updated and resubmited. It is also responsible for submitting a monthly performance report with a summary of performance monitoring
		It establishes the performance assessment periods for each performance parameter (day, week, month or quarter) and the periodicity of reporting (monthly, quarterly and annual)
Relationship management and resolution of conflicts and problems	Clause 36.8 – Disputes	Any dispute arising from an intervening event should be managed under the rules set in the accelerated dispute resolution procedure
	Article 48 – Termination	It establishes the grantor's right to terminate the contract for convenience with a notice given to the concessionaire no later than 90 days. Besides this discretion in termination, the grantor can also terminate the contract in case of a *force majeure* termination event or due to a default termination event (when a default occurs and cannot, or is not, solved)
	Article 50 – Dispute resolution	It establishes the procedure for any dispute resolution between the parties
		The dispute is initiated with a notice by one of the partners, identifying the dispute and the argument
	Article 52 – Accelerated dispute resolution procedures	This is a quick mechanism for dispute resolution, when the senior managers are not able to find a solution. An independent reviewer should be

(continued)

Table 4.2 (continued)

Key-elements	Contract clauses	Summary of the information
		appointed by both parties (within five business days), but if there is no agreement, then the Minister should appoint the independent reviewer. He can ask for information and documentation to any party
	Article 53 – Arbitration	The arbitrator should be appointed by agreement of the parties, within five business days of the dispute. In case there is not an agreement, the arbitrator has to be nominated by the Australian Centre for International Commercial Arbitration
Information and knowledge management	Clause 48.5 – Transfer of other assets	After contract termination, the concessionaire has the obligation to provide the grantor with the "originals or certified copies of all books, records, plans, drawings, specifications and documents"
	Article 59 – Confidential information	The concessionaire cannot disclose any information, except when required by law, or if necessary to comply with its obligations or resolving a dispute. The same applies to subcontractors or any relevant person
		The grantor can disclose information due to Minister requirements, parliamentary accountability, request by the Victorian Auditor-General or Victorian Government, and due to the Freedom of Information Act or the Ombudsman Act
Event management	Article 34 – Change in law or change in policy	It determines that the concessionaire has the right to compensation when changes in law or in policy take place
	Article 36 – Intervening events	The article sets the procedure for any intervening event that might delay or comprise the concessionaire performance and obligations
	Article 45 – Emergency events	It establishes the procedure in case of emergency events. If an emergency event occurs, the affected party should notify the other party. If the grantor exercises some of its rights (e.g. step-in), the concessionaire is exempt from his obligations during that period. Once the grantor ceases to exercise its rights,

(continued)

Table 4.2 (continued)

Key-elements	Contract clauses	Summary of the information
		the concessionaire obligations recommence immediately
Contingency planning	Article 35 – *Force majeure*	It establishes the procedure that the concessionaire needs to follow in case of a *force majeure* event. He needs to notify the grantor about the nature and impact of the event, as well as the implications for the service provision. Both parties need to meet within five business days after the notification. It also sets the conditions under which the payments can be made during this period

4.5.3 Golden Ears Bridge Project (Canada)

The Golden Ears Bridge project is a crossing of the Fraser River in the Greater Vancouver Region, consisting of 40 lane-km of grade-supported roadway plus 20 lane-km of roadway over bridge structure. The purpose of this PPP project was to improve accessibility and mobility to an area with high population growth. The project was developed under a concession agreement between TransLink (Metro Vancouver's Regional Transportation Authority) and the Golden Crossing General Partnership to design, construct, finance, operate, maintain and rehabilitate the bridge for a 35.5-year period. This corresponds to an estimate of 3.5 years for construction plus 32 years for operation. The investment in construction was around 800 million Dollars. Table 4.3 presents the key elements of the contract management of the Ararat Prison.

4.5.4 Hospital of Braga Project (Portugal)

The Hospital of Braga is a PPP project signed in 2009 that includes the construction and operation of a new hospital unit in the region of Braga (200,000 inhabitants). This PPP model is included in the so-called first wave of PPP arrangements in the Portuguese health sector and includes a partnership for the construction and maintenance of the hospital building with a duration of 30 years and a clinical management plan with a contractual term of 10 years. The total investment is 795 million Euros, of which 120 million correspond to the construction of the building. The project covers an area of approximately 99 thousand square meters and contains a total of 706 beds.

Table 4.4 presents the main clauses and a summary of the information contained in the contract management of the hospital of Braga.

Table 4.3 Key elements of the contract management of the Golden Ears Bridge Project (Canada)

Key-elements	Contract clauses	Summary of the information
Analysis and collection of information	Clause 3.4 – Disclosed Information	The concessionaire guarantees that the disclosed information is "accurate, complete, appropriate, comprehensive, exhaustive or reliable in whole or in part"
	Schedule PA2 – Design and build agreement	The concessionaire should provide the grantor will all information regarding design and build activities, through monthly status reports and other non-periodic reports. The concessionaire should keep a complete record of documents regarding these activities
	Schedule PA3 – Operation, maintenance and rehabilitation agreement	The concessionaire should provide the grantor will all information regarding operation, maintenance and rehabilitation activities, through periodic and non-periodic reports. The concessionaire has to guarantee a complete record of all data
Contract administration	Article 7 – Payments	It establishes the conditions for performing the contracted payments (e.g. timing, taxes, among others)
	Schedule PA-8	It defines the payment mechanism as well as the deductions for non-availability and for non-conforming event
Governance	Schedule PA14 – Dispute resolution procedure	It sets the governing principles for dispute resolution, namely: both parties will try to be prompt and timely in solving disputes, will try to solve any dispute in an amicable negotiation and provide "frank, candid and timely disclosure of all relevant facts, information and documents" that may be useful in solving any dispute
Continuous revision	Article 10 – Change process	Any change in the contract management process should be taken as a "regular" contract change, and therefore must comply with Article 10 (described ahead in "Event management")
Monitoring and performance reporting	Schedule OMR2 – Asset preservation performance measure	It establishes a performance measurement plan, incorporating three levels of performance measure: key performance measures (principle outcomes of the concession), asset preservation performance measure (criteria for individual assets performance) and operational

(continued)

Table 4.3 (continued)

Key-elements	Contract clauses	Summary of the information
		performance measure (criteria for individual assets performance and corridor management performance). Each KPI should be measured and reported with a certain periodicity
Relationship management and resolution of conflicts and problems	Article 11 – DBFO contractor default	It establishes the rules to deal with any default by the contractor. It determines that the concessionaire has to solve any default within 20 business days after being notified by the grantor. In case the default cannot be solved, it should present a plan and schedule to solve the problem. If the grantor does not accept the proposed plan and schedule, it should notify the concessionaire within 20 business days
	Article 12 – Translink default	It sets the events that constitute a grantor's default: delay in contracted payments, if it fails to comply with the requirements or directives of a final award, just to mention some examples. In case of a default by the grantor involving the non-payment of an amount, in a matter that is not subjected to litigation, the concessionaire can notify the grantor that has a 10 business day's deadline to transfer the amount, after which the concessionaire can terminate DBFO agreements. The concessionaire is entitled the right to be reimbursed by the costs it incurred with the grantor default
	Article 13 – Termination procedure	The grantor or the concessionaire can terminate the contract in case of unsolved defaults presented in Articles 11 and 12
	Article 14 – Effect of termination	It establishes the implications of termination. In case the contract terminates due to the grantor default, the concessionaire is entitled the right to a compensation designated "TransLink Default Termination Sum". In case of termination due to the concessionaire default, the grantor should receive either the adjusted highest qualifying bid price or the adjusted estimated fair value determined by Article 16. In case of termination due to the concessionaire

(continued)

Table 4.3 (continued)

Key-elements	Contract clauses	Summary of the information
		default, the grantor should gather independent experts to investigate and assess the assets (the resulting reports and studies are designated "independent remedial information")
	Article 15 – Rebidding procedure	It sets the rules and conditions for the rebidding procedure. The objective is to identify the "highest qualifying bid price". The grantor can disclose the independent remedial information, and use the information it finds suitable in the bidding process
		After the rebidding process, if the grantor does not receive any qualifying bid, the compensation paid to the concessionaire (in case of grantor default) is equal to the adjusted estimated fair value. If it receives at least two qualifying bids, the amount should be equal to the Adjusted Highest Qualifying Bid Price
	Article 16 – Estimated fair value procedure	The calculation of the value should consider: the independent remedial information, all future capital payments, all forecasted costs (including risk assessment of overruns), the costs of performing or causing the performance of the design and build plus operation and maintenance, and the repairs and replacements, among other costs
		If the parties do not agree on the estimated fair value procedure, then it should be determined by dispute resolution procedure
	Schedule PA14 – Dispute resolution procedure	Schedule PA 14 is part of the contract and contains the dispositions related to the dispute resolution procedure
		Any dispute should be communicated to one party to the other. The first level of dispute resolution is through senior manager's negotiation. If this fails, then each party should nominate a referee. If there is dispute regarding the referee report ("Referee dispute notice"), the dispute shall be solved by arbitration or, if the parties do not agree, within a court of competent jurisdiction in Vancouver. The arbitration is determined by a single

(continued)

Table 4.3 (continued)

Key-elements	Contract clauses	Summary of the information
		arbitrator, and managed by the Rules of the British Columbia International Commercial Arbitration Centre
Information and knowledge management	Clause 14.4 – Transfer of assets	Upon termination the concessionaire should transfer to the grantor all information regarding the concession (that has not been delivered at the time) in electronic format, or other designed by the grantor
	Article 23 – Confidential information	It establishes that each party will not disclose any information classified as confidential, except under special circumstances (e.g. required by law)
Event management	Clause 6.15 – Fraser River Port Authority Lease	It analyses the implications of the concessionaire of changes in the ownership of the Fraser River Port Authority Lease, or even in cases of default
	Article 8 – Change in law	It defines the conditions under which both parties should act in case of changes in the law with impact on the concession
	Article 10 – Change process	It sets the rules for managing any change. Each party has an 18-month maximum period to inform the other partner of the change. In case of any change required by the concessionaire, the grantor has to evaluate and assess the impacts of such change, informing the concessionaire, and has to approve or reject the submission within 20 business days. It also presents the principles for evaluating the changes and calculating possible compensations. As far has this is concerned, the contract states that the concessionaire should be placed in no better or no worse position than if the change did not occur
Contingency planning	Article 9 – *Force majeure*	It establishes the conditions under which both parties should act in case of *Force majeure* events, even considering the case of contract termination due to these events. The party that suffered the effect of the event should notify the other party describing the event and indicating its impact

Note: Schedules are a part of the contract

Table 4.4 Key elements of the contract management of the Hospital of Braga

Key-elements	Contract clauses	Summary of the information
Information planning, gathering and analysis	Clause 131 – Periodic information	It defines the information that must be submitted by the concessionaires to the government in each year of operation and always until April 15 of the year following the one reported. These documents include management reports and accounts, a quarterly activity report, and an annual activity report, among other things
Contract administration	Clause 128 – Powers of the Government and Concessionaires	It says that contract management and the monitoring of the activities of the concessionaires belongs to the government, and it is also the government's responsibility to verify the fulfillment of the contract, assuming the functions of inspection and oversight. The Minister of Health can delegate to the contract manager his legal or contractual powers referred to in the contract
	Clause 129 – Contract Manager	A contract manager is created to assure the activities needed for appropriate and effective contract management. He is named by the government, and the concessionaires will be notified 5 days after signing the contract
	Chapter II – Common Management Clause 132 – Description and composition	Under the scope of contract monitoring, a joint commission should be put together with elements from each of the partners and a representative of the Health School of the University of Minho, which should have access to the aspects directly related to the educational activity
	Clause 133 – Ombudsman	The government should appoint an ombudsman, whose main task is to take measures to solve the malfunctions involving patients. To do this, the ombudsman must have access to complaints and suggestions and may issue recommendations leading to solving the problem
Performance control and reporting	Section III – Monitoring system and information systems Clause 21 – Monitoring systems	It says that all performance evaluation should be ensured through a monitoring system made from the information systems of the concessionaires, and the monitoring system should allow the assessment of the implementation of the

(continued)

Table 4.4 (continued)

Key-elements	Contract clauses	Summary of the information
		performance parameters defined in contract annexes. This monitoring system must be automatic. Concessionaires shall ensure continued access to the system by the contract manager. This system must allow data export in a standard structured format
	Clause 22 – Principles of the monitoring system	It defines two structuring principles for the monitoring system: (a) maximize the performance of the concessionaire, identifying situations of non-compliance; and (b) centralize the registration of cases and the results of monitoring activities
	Clause 23 – Performance parameters	The performance parameters are defined in contract annexes and include, among others, parameters such as the number of external queries and conventional surgery and outpatient surgeries. These parameters can be revised depending on a joint decree of the Ministers of Finance and Health. They can be revised unilaterally by the government provided that they do not increase the total number of parameters and penalty points.
	Clause 53 – Performance assessment	The performance of the concessionaire (building) is performed by three areas of evaluation: results, service and customer satisfaction
	Clause 54 – Performance failures of the concessionaire	If any of the performance parameters are not met, it will determine the occurrence of a failure of the performance. The failures can be classified as follows: specific failures, faults, and failures of service
	Clause 55 – Calculation of deductions	In the case of specific failures, a sum should be deducted to the payment corresponding to the price calculated based on the terms of the NHS price list, with a duration equal to the average delay
	Clause 107 – Performance assessment	The evaluation of the concessionaire performance (clinical services) includes three distinct areas:

(continued)

Table 4.4 (continued)

Key-elements	Contract clauses	Summary of the information
		availability, service and customer satisfaction
	Clause 108 – Performance failures	There is a failure in performance management when the performance parameters are not fulfilled. These can be of two types: failures of service or failures of availability
	Clause 109 – Calculation of deductions	The calculation of deductions is the result of multiplying the number of penalty points by the unit value of each penalty point, limited to a maximum of 10 % of the annual remuneration. It is deemed that a functional part is not available when the conditions of accessibility, security and use are at risk
Relationship management, resolution of disputes and problems	Clause 136 – Mediation	Any dispute between the parties can be submitted to the mediation of a third entity defined by an agreement
	Clause 137 – Arbitration	It points to arbitration as the preferred way to resolve disputes that may arise, referring to a competent jurisdiction to review the precautionary measures that may be presented
	Clause 138 – Court of arbitration	This point defines the guidelines of the formation and function of the court of arbitration.
	Clause 139 – Disputes involving subcontractors	In the case of a dispute involving subcontractors, they can be called to intervene by either party
Principles of corporate governance, ethics and honesty	Clause 129 – Contract manager	It establishes the obligation of cooperation between concessionaires and the contract manager team, and the cooperation must be guided by good faith and without skepticism
	Clause 134 – Contract of use	It says that the concessionaires must act diligently and in good faith to ensure compliance with the performance parameters to which both are subject
Information and knowledge management	Clause 18 – Principles applicable to information systems	It determines that the government must adopt information systems to monitor and supervise the activities of the concessionaires and that it sets the principles governing these information systems.
	Clause 19 – Procedure for the information collection/processing	It defines the procedures relating to information systems, particularly

(continued)

Table 4.4 (continued)

Key-elements	Contract clauses	Summary of the information
		the ones dealing with the collection and processing of information
	Clause 20 – Databases and application support solutions	It sets the storage requirement in computer-readable form, duly updated and with complete user manuals.
	Clause 141 – Communications	It defines the forms of communication between the parties, namely: hand delivery; registered letter with acknowledgement of receipt; fax and e-mail
Change management (restoring and changes to the contract)	Clause 127 – Financial balance restoring	The contract includes the possibility of restoring the financial balance of the contract if there are significant changes of the financial terms of the contract, such as in the following cases: unilateral modification (government), cases of *Force majeure*, changes in the legal framework and unilateral decision on new therapies. In the event of a real shareholder IRR reduction of more than 0.01 % by an individual or the cumulative effect of one of the previous cases deeming the value of 8.64 % of the financial model, the private partner has the right to restore financial balance
		The concessionaire has the right to restore the financial balance if the reduction of the actual shareholder IRR is over 0.01 % compared to the value of 6.99 % of the financial model or if there is a reduction of the annual Debt Service Coverage Ratio (DSCR) on more than 0.01 % compared to the financial model. Restoring the financial balance should be achieved through direct compensation
Contingency planning	Clause 20 – Databases and applicable support solutions	In case of contract termination or reversion of the hospital, the board of directors shall transfer the databases to the government or third parties, being obliged to provide training and support for a maximum of 80 hours

4.6 Common Practices and Sins of Contract Management

Although some of the key elements of the contract management are present in the contracts analyzed above, actually, in most of the empirical cases found worldwide there is no systematized or standardized contract management of PPP projects. Among the main weaknesses identified, the following are to be highlighted:

(i) The absence or achievement out of time of the Contract Management Guide;
(ii) The lack of follow-up (or even existence) of contract tendering process phase by the management team;
(iii) The scarcity and lagging of the resources available to the administration of the contract;
(iv) Aspects of governance that are not considered;
(v) An ineffective performance monitoring, for example, in the application of sanctions (e.g. in the hospital sample presented before sanctions have been applied without practical result because the concessionaire appealed to the courts and they prescribe in time);
(vi) Relationship management is very formal and very extreme in the event of a conflict;
(vii) The absence of contingency plans;
(viii) A management of change that tends to be unbalanced and more favorable to the private partner (only provided for rebalancing in favor of and mitigating the risk assumed by the private partner);
(ix) A non-existent risk management;
(x) A deficit in the accumulation and management of knowledge and information by the public partner.

Therefore, a sound contract management reveals itself as one of main reasons for the success of the infrastructure PPP. Both partners gain with appropriate contract management. Sometimes, it might seem that the private partner profits with contract mismanagement but this is an illusion. The greater hypothesis of escalation of conflicts is such that the private partner should be the first to favor and contribute for the adequacy of contract management.

Some of the main "sins" sometimes found in contract project management are presented next:

– **Alienation**: as the public partner has delegated the majority of the operational activities he feels that he does not have to intervene. This passive behavior leads to an absence of contract management except for the obligations defined in the contractual clauses (for example, the performance monitoring or the application of sanctions). Contract management is more than strictly complying with the clauses of the contract since, as already pointed out, 'contracts are incomplete' and need the visible hand of the contract management team for the PPP project to attain its objectives;
– **Interference**: when the public partner tries to impose his practice to the private partner (often associated with a feeling that the public partner is the one who holds the knowledge). This is frequent and might avoid the transference of risk and lead to the assumption of risks by the public partner, which were supposed to

have been transferred to the private one. For example, if the public partner intends to approve the final technical designs of the infrastructure, he can be assuming the design risk which a priori is assigned to the private partner;
- **Informal management**: when the contract is understood as a purely administrative document and contract management is informal and made personal. This happens when there is some laxity by the public sector and it tries to (mis) manage the contract itself directly. Moreover, as the infrastructure contracts are long term and therefore today's contract managers are not the same of tomorrow this can be troublesome;
- **Voluntarism**: when the public partner, filled with good reasons (e.g. compliance with the goals of the project), exceeds himself in help/assistance to the private partner and even replaces him in some tasks. If things do not run well, the public sector can bear itself the risks assumed. For example, it is frequent that the State helps the private sector, replacing it in carrying out the expropriations (and eminent domain issues), because it can be more difficult for the private sector to acquire the land. However, if due to this some delay happens, its consequences can be assigned to the public partner;
- **Authoritarianism**: when the public partner assumes an eminently inspecting posture (nearly as a policeman), undermining a constructive and healthy relationship. This quarrelsome behavior, earlier or later, might lead to an escalation of conflicts and it does not necessarily conduct to good results in terms of contract management and in the achievement of the objectives of the project;
- **Lack of strictness**: as a result of excessive awareness of the difficulties inherent to the development of the contract. This permissive attitude is risky and might conduct to an underperformance by the private partner. As a likely consequence the objectives of the project might be not achieved.

The art of contract management in PPP infrastructure consists of finding a balanced approach that avoids this kind of behavior.

4.7 Main Findings

In short, this section tried to highlight the importance of contract management in PPP arrangements of infrastructure and public services in its various functions, aspects and activities. It is not possible to develop successful projects if there is not a proper contract management.

This chapter started with an overview about contract management and its relevance for the success of any PPP project. Next, the major characteristics and objectives of contract management were presented and discussed. Irrespective of the type and nature of the infrastructure project, contract management aims to comply and achieve the objectives of the project for both public and private parties. For the PPP projects to be successful there cannot be winners and losers and a

balance between the parties' interests should occur. There is no other alternative for the survival of the long term PPP contracts. The absence or incompetence of the contract manager does not stop the contract and does not avoid the escalation of conflicts if the private sector is able to take advantage of them.

Afterwards, the following section presented the major dimensions of contract management in PPP infrastructure, such as those concerning the relationship management, operational management and administrative management. Usually, the focus of contract management is on the operation issues, such as the performance monitoring, the control of results or the management of interfaces, or even (less common) the risk management. However, the other dimensions are also fundamental for the accomplishment of the PPP contract. If some of the procedures of administrative management are included in the clauses of contract (for example the reporting, the payments or the documentation management), the relationship management is frequently forgotten. In fact, in long term PPP contracts, issues like communication, trust, cooperation, sharing, involvement and conflict management are very important, if not decisive.

In the fourth part, a contract management agenda was suggested. There, the main aspects, requirements and activities necessary for a sound contract management were proposed and discussed. Some of them were related to the functions of the contract management team, embracing four aspects/activities, namely planning, collection and analysis of information, contract administration, contract governance and its continuous review. The remaining activities to be developed in contract management encompassed the monitoring and reporting of performance, the relationship management and the resolution of conflicts and problems, the information and knowledge management, the event management and the contingency planning. All these aspects, requirements and activities should be carefully taken into account in contract management and predicted in the PPP project from the beginning and always before the contract is signed.

In the fifth part of this chapter three empirical case-studies in three different countries (Australia, Canada and Portugal) of PPP infrastructure contract management were analyzed, respectively a prison facility, a hospital and a bridge. It was shown and systematized how these PPP contracts were managed concerning the major issues of contract management in the three dimensions referred to. In the sixth part, the most usual weaknesses and the major sins in contract management practices were presented and discussed. One more time it is emphasized the role of relationship management and the balance between voluntarism, interference, formalism, alienation, authoritarianism and easiness that should be achieved. In PPP contracts this balance is even more difficult because there will be several teams (public and privates) due to the long-term nature of the contract.

Renegotiation

5

5.1 Introduction

Among the main advantages of concessions (contractual PPPs) over other PPP models is the idea that the existence of a contract between the parties allows them to understand the "rules of the game", thus avoiding discretionary behavior by regulators (Gómez-Ibañez 2003) and preventing opportunistic behavior by either the concessionaires or governments. However, empirical evidence shows that concessions often suffer from a major shortcoming: renegotiations (Guasch 2004; Guasch et al. 2006, 2007, 2008; Engel et al. 2003, 2009a, b; Marques and Berg 2010). A renegotiation happens when the contract fails to address present circumstances. Either the assumptions made initially are no longer accurate (traffic or consumption forecasts, cost estimates, interest rates, etc.) or one of the parties engages in unilateral contractual changes, making the original contract difficult to comply with for both parties.

Contract theory explains renegotiation based on the incomplete nature of contracts (Tirole 1986). Concession contracts are particularly vulnerable to incompleteness because of their length, which can be as long as 50 or 60 years. Notwithstanding improvements in econometric forecasting, it is impossible to forecast cost estimates several decades in advance. Even during the construction phase, cost estimates are often biased, but estimation is even more difficult for the demand and macro-economic variables (Flyvbjerg et al. 2004).

One might expect that in the medium and long term, contracts have to be renegotiated, but empirical evidence shows that a large number of renegotiations occur in the concessions' first years. In fact, some objective reasons might be found for this behavior. In greenfield projects, there is no prior knowledge on the demand or on the construction costs.

Therefore, even though similar projects might have been developed, for that particular project, most of the risk will be unveiled in the early years, with construction and demand risks on top of the list. Construction will tend to happen within the first 1–5 years of the project depending on the size and complexity of the

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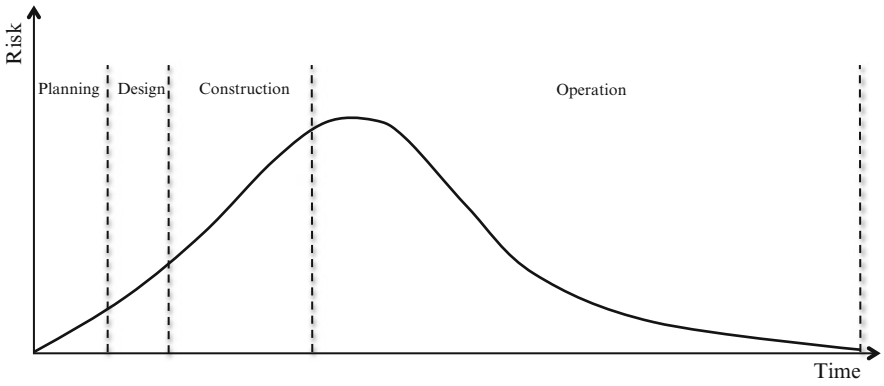

Fig. 5.1 Schematic curve of a concession risk profile over the life-cycle

infrastructure. After the construction is finished, most of the risk is eliminated. This is the reason why many (successful) projects obtain refinancing after construction. The overall risk of the project declines significantly, and the cost of capital decreases. In brownfield projects, there are some data on previous demand behavior. For example, if the project intends to increase capacity, or the quality of service, in a highway or a water system, it is relatively easy to forecast *ex post* demand. In greenfield projects, the uncertainty is much higher, and the forecasts are tested immediately after opening (see Fig. 5.1).

In the planning phase, the main risk is political. During the initial stage of the project, a preliminary CBA is performed to assess whether the project should go forward. It is during this period, especially for large-scale projects (e.g., dams, light rail systems or airports), that political parties can use the project for political dispute. Different parties have different ideas about the project, and who "owns" the political power will tend to decide the outcome of the project. It is not rare for parties to have different positions toward the project, depending on whether they are the opposition or the government.

In the design phase, there is the risk of mismatch between the plans and the real operation of the service. There are also the risks inherent to designing complex civil engineering works. For example, there are assumptions made based on a preliminary analysis that might prove to be wrong or incomplete. Construction is a particularly risky phase. Civil engineering works, particularly those in non-standardized structures, are vulnerable to several risks: geotechnical, archaeological, and design, all of which can have severe impacts on the costs and duration of construction. Once the infrastructure is built, the construction risk decreases, but the demand or consumption risk increases. In greenfield projects, this is the most risky point in the life-cycle. After the initial demand is known, the risk decreases over time. In the first couple of years, the risk is still significant because the infrastructure is being tested by normal operation, but after this period, the risks are mostly the ones inherent to the operation of the service.

Theoretically, renegotiations should be used to manage contingencies, meaning that they should be used as a tool for risk management. However, the reality is quite different. Opportunistic behaviors, VfM erosion and difficulty in protecting the public interest are some observable events.

This chapter intends to provide answers to the following questions. How and why do renegotiations happen? What are the most common patterns? What are the costs and causes? What are the main determinants? What tactics should be used to avoid or control the renegotiation process? Is it possible to identify some of the main determinants that help explain the greater probability of renegotiating some contracts rather than others? To allow for a deeper and structured analysis, the main determinants for renegotiations are categorized into two groups: exogenous and endogenous variables. Exogenous refer to the project's characteristics (dimension, complexity, sector, etc.), while endogenous refers to contractual clauses (such as the existence of a clause ensuring a determined IRR, limiting the VaR). This chapter is organized as follows: after this brief introduction, a literature review on renegotiations will be made, followed by a theoretical discussion of the main determinants of renegotiation; this discussion will be supported by an empirical analysis; the main costs and causes of renegotiation will also be addressed along with the phenomenon of cooperative renegotiation. The chapter also includes a set of guidelines for avoiding renegotiation or, at least, decreasing the likelihood of a negative outcome from a public sector perspective. Finally, some conclusions and policy implications will be presented.

5.2 The Problem of Renegotiation: Literature Review

Most theoretical models and contributions to the problem of renegotiation were made in the 1980s and early 1990s based on agents' behavior modeling. The seminal work of Williamson (1976) on contract incompleteness and of Goldberg (1976) and the works developed by Holmstrom (1982), Tirole (1986), Dewatripont (1988) and Hart and Moore (1988) on information asymmetry and strategic (opportunistic) behavior provided the ground theory for renegotiation analysis.

During the 1990s and 2000s, following the worldwide development of several infrastructure plans, particularly in Europe and Latin America, several empirical papers emerged, presenting empirical evidence of the phenomenon (Crocker and Reynolds 1993; Artana et al. 1998; Guasch 2004; Guasch and Straub 2006; Engel et al. 2003; Vassallo 2006). This type of insight provided invaluable evidence on how governments and concessionaires effectively tackle renegotiations, how often they do it and why it happens.

This research follows the second wave of renegotiation literature, and it provides most of the conclusions and recommendations built over the real data of infrastructure concessions development and management. It goes a step further by analyzing the endogenous and exogenous determinants of renegotiations. Some of the previous works noted the importance of accounting to embedded contractual clauses as

one of the main reasons for renegotiation, but, to the knowledge of the authors, no previous studies have addressed this issue.

Renegotiations arise because of the inadequacy of the contract to address contingencies. Tirole (1999), using transaction costs theory,[1] argues that the forecast of all possible contingencies represents a very high cost, and therefore, agents choose to live with some degree of uncertainty. This problem is even more acute when in the presence of relation-specific investments (Hart and Moore 1988). Crocker and Reynolds (1993) claim that in more complex sectors (higher demand uncertainty, technological risk, high number of stakeholders, etc.), the most problematic is contract incompleteness.

In infrastructure sectors, besides the complex surrounding environment and significant relation-specific investments, there is the monopolistic nature of the market. Many authors have devoted their studies to the problem of contract incompleteness in monopolies (Demsetz 1968a; Williamson 1976; Hart and Moore 1988).

Table 5.1 presents a summary of the main literature review about renegotiations, classifying each contribution according to the type of document, geographical scope, type of analysis and briefly describing the main findings.

The literature between the 1970s and late 1990s is essentially theoretical. It is mostly over the last 10–12 years that several empirical studies have emerged. This is not a surprising fact because most PPP were developed during this period. As discussed later on this chapter, most empirical studies confirm what theory has stated.

The initial rationale for renegotiations was developed around the question of opportunistic behavior (Williamson 1976). Foreseeing all possible contingencies requires high transaction costs, and therefore, contracts are inherently incomplete, allowing for opportunistic behavior. An example is the strategic behavior of concessionaires, under-bidding and engaging in rent seeking strategies after the contract is signed, as described by Bajari and Tadelis (2001), Guasch (2004) and Bajari et al. (2007). The cases of the airport concessions in Argentina and Honduras are textbook examples. The concessionaires overpriced the airports, faced difficulties in complying with the investment plan, and later required more favorable conditions (Lipovich 2008).

After the renegotiation starts, there is another classical and well-documented problem known as information asymmetry (Stigler 1961; Spence 1973). The concessionaire has more knowledge about the business' main determinants such as cost functions, operational or other critical issues, than the government. In this highly asymmetric environment, it is difficult to ensure terms that maximize the social welfare, allowing the concessionaire to easily impose his own requirements (Marques and Berg 2010). Williamson (1985) goes a step further, claiming that the information asymmetry problem does not solely affect renegotiation outcomes but also can provide leverage in a rebidding process.

[1] See more in Demsetz (1968b).

Table 5.1 Summary table of literature review

Year	Authors	Type of document	Type of analysis	Main findings
1976	Williamson	Paper	Theoretical	In this seminal work, the author discusses (against the prevailing economic thinking) that franchising for natural monopolies suffers from "contractual disabilities"
1978	Klein et. al	Paper	Theoretical	The authors argue that post-contractual opportunism is particularly "bad" when the asset has a high degree of specialization, i.e., the "value for a given use is much higher than the value of its next highest use". In those cases where these assumptions are true, there is an incentive for vertical integration
1979	Williamson	Paper	Theoretical	The authors argue about the risk of renegotiation in the presence of "transaction-specific capital" when unexpected events occur
1982	Holmstrom	Paper	Theoretical	Looking at the problem of *ex post* renegotiation, the author specifies the problem as a "moral hazard in teams". The problem of underinvestment is explained by the fact that only one party captures the full marginal benefits of investment increases
1986	Tirole	Paper	Theoretical	The author argues that parties engaged in an incomplete contract have incentives to renegotiate as soon as they acquire new information. The firm learns its production costs and the sponsor the value of the project. It also claims that the cancellation fees may lead to under-investment
1988	Dewatripont	Paper	Theoretical	The author claims that regardless of the fact that information asymmetries usually decrease the welfare (considering that the goal is optimal risk sharing), they may in fact improve the welfare if the goal is commitment against outsiders
1988	Hart and Moore	Paper	Theoretical	The author assumes the impracticability of specifying all possible contingencies into contracts and analyses optimal contracts in two cases. If relationship-specific investments are undertaken, it is not possible to implement the first best, but if there are no investments, then the "first-best provided messages sent between the agents can be publicly verified"
1992	Green and Laffont	Paper	Theoretical	The author presents "efficient contracts" as those able to recognize uncertain events, and if they are capable of being renegotiated voluntarily, they can be better off in doing so. When designing the contract, they can anticipate this renegotiation phase. The paper also claims that no matter who has the bargaining power, it is always better to have a contract than to have none

(continued)

Table 5.1 (continued)

Year	Authors	Type of document	Type of analysis	Main findings
1993	Crocker and Reynolds	Paper	Empirical	This paper highlights a discussion on the costs of contract incompleteness, stating that the greater the complexity of the sector on which the contract develops, the greater these costs will be
1994	Aghion et al.	Paper	Theoretical	The authors argue that "efficient investments and optimal risk sharing can typically be achieved provided that the initial contract is able to monitor the *ex-post* renegotiation process." "The analysis focuses on two features of renegotiation design: default options and the allocation of all bargaining power to either contracting party". Moreover, they show that these two features can be obtained in standard Rubinstein bargaining games through contractual provisions, such as specific-performance clauses and penalties for delay (or, equivalently, financial "hostages" refundable without interest)
1997	Edlin and Hermalin	Working paper	Theoretical	The research focuses on the "ability of an agent and a principal to achieve the first-best outcome when the agent invests in asset that has greater value if owned by the principal than by the agent." "Investment by the agent can increase his value for the asset, thus improving his bargaining position in renegotiation." "The authors consider that achieving the first best is difficult (or impossible) and that if parties have an appropriate signal available, then the first is still attainable for a wide class of bargaining procedure"
1998	Artana et al.	Working paper	Empirical	The authors evaluated contractual adjustments, renegotiations and disputes that occurred in Argentina in several public utility industries. The database included 12 cases. The main conclusions are that deficient design fosters renegotiations as well as poor competition in the award process
1999	Hart and Moore	Working paper	Theoretical	The authors developed a theoretical model to support the thesis that contracts are always incomplete
	Maskin and Moore	Paper	Theoretical	The authors characterize "the choice rules that can be implemented when agents are unable to commit themselves not to renegotiate the mechanism"
	Tirole	Paper	Theoretical	The author presents some methodological insights on the standard approach to modeling incomplete contracts, namely the existence of transaction costs and rationality, and he "argues that contrary to what is commonly defended, the complete contract methodology does not account for standard institutions such as authority and

(continued)

Table 5.1 (continued)

Year	Authors	Type of document	Type of analysis	Main findings
				ownership; it concludes with a discussion of the research agenda"
2001	Bajari and Tadelis	Paper	Empirical	The authors argue that for complex contracts, the cost plus schemes decrease the likelihood of opportunistic behavior because more adaptations are required
2003	Engel et al.	Paper	Empirical	This paper addresses the development of a formal model where authors using a Latin American sample demonstrated that whenever the privatization of a highway is optimal, government transfers are undesirable. The role of flexibility was evaluated, and the conclusion was that "a flexible term franchise provides flexibility without inducing opportunistic behavior" and, therefore, decreases the risk of renegotiation
	Estache et al.	Working paper	Empirical	This research is based on a database on drivers for contract renegotiation in Latin America. The main objective was to assess the impact of the "price cap" regulatory regime. The authors claim that "efficiency gains were amply achieved" and that "these gains were seldom passed on to the users" but were rather shared by the government and firms. The main outputs were the higher costs of capital, the higher tariffs and the low levels of investment
2004	Guasch	Book	Empirical	This book uses a database from Latin American concessions to determine the drivers of renegotiations and its causes and impacts and draws important policy implications
	Nombela and Rus	Paper	Theoretical	The authors discuss how the franchise mechanism for road provision does not generally yield optimal outcomes and might result in frequent contract renegotiations observed in practice. An alternative procurement method is proposed based on a flexible-term contract and bi-dimensional bids for total net revenue and maintenance costs. The authors' rationale is that this new mechanism eliminates traffic risk and allows for selecting efficient concessionaires
2005	Guasch et al.	Working paper	Empirical	This paper is a sequel and develops an extension of the analysis of the case of government-led renegotiations. A formal model is developed, and an empirical analysis with a sample of 307 projects (water and transport) in Latin American developed between 1989 and 2000 is conducted. The authors found evidence of the importance of having a regulator when awarding concession and of the fragility of the regulation by a price-cap.

(continued)

Table 5.1 (continued)

Year	Authors	Type of document	Type of analysis	Main findings
				The investment and financing issues and the corruption variables were analyzed
2006	Bennet and Iossa	Paper	Empirical	The authors developed a model to evaluate alternative institutional arrangements for buildings and managing infrastructure in the UK, incorporating the effects of innovative investment by providers
	Vassallo	Paper	Empirical	The author proposes three alternative auction mechanisms in Chile to address traffic risk and decrease the risk for renegotiation by focusing on three mechanisms: the 'Minimum Income Guarantee' (MIG), the 'Least Present Value of the Revenues' (LPVR), and the 'Revenue Distribution Mechanism' (RDM)
	Guasch and Straub (2006)	Paper	Theoretical	The authors developed a regulation model to evaluate the imperfect enforcement of concession contracts dealing with renegotiations. The impact of the probability of renegotiation was tested for regulatory policy, institutional features, economic shocks and some other contract features
2007	Bajari et al.	Working paper	Theoretical/ Empirical	The authors developed a model of bidding for incomplete contracts and tested data from highway paving contracts. Using reduced form regressions, evidence was found of the strategic response of bidders to contractual incompleteness and adaptation costs. A second structural auction model concluded that the adaptation costs account for about ten per cent, on average, of the winning bid
2008	Guasch et al.	Paper	Empirical	Using a data set of 307 concessions awarded in Latin America from 1989 to 2000, the authors look at the impact on the probability of renegotiation of a concession, of regulatory institutions, institutional features, economic shocks and of the characteristics of the concession contracts themselves. Policy implications are also formulated
	Estache and Wren-Lewis	Working paper	Theoretical	The authors review the work conducted by Jean-Jacques Laffont on developing economies, described as "economies with missing markets". They argue that "missing markets" can be understood, for regulatory purposes, as incomplete markets, concluding, contracts are incomplete because of players' bounded rationality, as in any economy
2009	Brux	Paper	Empirical	This paper presents a different view on renegotiations based on the cooperation of both parties using a French case-study. The authors argue that when "parties give an important value

(continued)

Table 5.1 (continued)

Year	Authors	Type of document	Type of analysis	Main findings
				to their present and future bilateral relationships, they are prone to find solutions that are sustainable and profitable for both parties. Even acting according to their own self-interest, at the stage of renegotiation, parties try to maximize joint utility. In this way, they reinforce the durability of their relationship"
	Casas-Arce and Kittsteiner	Working paper	Theoretical	The authors support the thesis of post-contractual opportunistic behavior bypassing their original agreement, leading to a reduction in the value of contracting by limiting the effectiveness of contractual incentives
	Engel et al.	Working paper	Theoretical model	The authors develop a model for renegotiations and concluded that there is evidence of "*(1)* in a competitive market, firms lowball their offers, expecting to break even through renegotiation, *(2)* renegotiations compensate lowballing and pay for additional expenditure, *(3)* governments use renegotiation to increase spending and shift the burden of payments to future administrations, and *(4)* there are significant renegotiations in the early stages of the contract, e.g., during construction". The theoretical results were compared against real data from Chilean renegotiations of PPP contracts. The research also claims that if "PPP investments are counted as current spending, the incentives to renegotiate contracts to increase spending disappear"
2009	Estache et al.	Paper	Empirical	The authors used data from road and railway concessions in Latin America to examine the probability of renegotiation using different award criteria. They concluded that "auctioneers tend to adopt the multidimensional format when the need for social considerations, such as alleviation of unemployment, is high" and also that "more renegotiations would likely happen when the multidimensional format is used". The authors claim that good governance (regulatory quality and anti-corruption policies) is the best tool to mitigate the renegotiation problem
	Guash and Straub	Paper	Empirical	The research used a panel dataset of over 300 concession contracts from Latin America between 1989 and 2000. Evidence was found that country-level corruption is a significant driver for renegotiation. "While a more corrupt environment clearly leads to more firm-led renegotiations, it significantly reduces the incidence of government-led ones"

(continued)

Table 5.1 (continued)

Year	Authors	Type of document	Type of analysis	Main findings
	Littlechild (a)	Paper	Empirical	Looking at settlements in the Florida electricity sector, the author argues that "stipulations have changed the form and nature of regulation: away from a conventional rate of return approach to a fixed-price approach, and later away from incentive schemes with profits caps to stronger and more enforceable incentive schemes without profit caps"
	Littlechild (b)	Paper	Empirical	The author analyses data from Florida utilities. It concludes that between 1976 and 2002, "30 % of earnings reviews were settled by stipulations involving the Office of Public Counsel but only 7 % of company requests"
2010	Gagnepain et al.	Working paper	Empirical analysis	The authors discuss how extending contract length and increasing commitments can achieve fair gains. The case study is the French urban transport sector
	Viegas	Paper	Empirical	The author considers the possibility that concession length does not allow full amortization. This would lead to shorter contracts and more frequent re-bidding. Though it may increase transaction costs, it would also avoid "the loss of welfare due to the poor fit of the contract after 20 years or so"
	Marques and Berg	Paper	Empirical	The authors argue about the effect of poorly prepared tender procedures in the occurrence of renegotiations. The contract design is also analyzed, and potential mitigation strategies are proposed
	Baeza and Vassallo	Paper	Empirical	The authors analyzed data from Spanish toll motorways and found evidence of frequent renegotiations, essentially because of the winner's course and an inefficient allocation of traffic risk, based on excessively overoptimistic forecasts. This led to changes in tolls and extensions in contracts

n.a. non applicable

Even though this discussion claims that the concessionaire has the leverage power in renegotiations, both theoretically and empirically, it is possible to place the negotiation power on the government side. In most infrastructure concessions, the concessionaire engages in high sunk investments and can become vulnerable to political instability (Engel et al. 2006). Guasch and Straub (2006, 2009) show that in Latin America, the government renegotiated 41 % of concessions, decreasing the concessionaire commitment to the project and ultimately leading to underinvestment, as in the case of the water supply system in Limeira, Brazil (Guasch 2004).

Either initiated by the government or by the concessionaire, there are several critical determinants behind the renegotiation process that influence the probability of occurrence and the possible outcomes. In the next sections, based on theoretical propositions and empirical observation, the authors establish a framework for the main determinants of the renegotiation process.

5.3 Structuring the Renegotiation Determinants

As mentioned earlier, determinants are those factors that influence the probability of renegotiation and/or its outcomes. Cruz and Marques (2013b) have developed a two-class structure to clarify the type of determinants involved in renegotiations. The two classes are exogenous and endogenous determinants, or whether the factors are external or internal, respectively, to the contract (Table 5.2).

Exogenous determinants are external factors to the contract, i.e., more related to the external environment, sector, regulator, or even some project features but not to contractual clauses that influence the likelihood of renegotiation. These last determinants are considered endogenous. The next sub-sections will present a theoretical list of the main exogenous and endogenous determinants for renegotiations. Some of the determinants may not be applied in a certain country or to some types of projects. Rather, they represent various theoretical possibilities. The endogenous determinants are related to contractual clauses that somehow have an impact on renegotiation.

5.4 Exogenous Determinants for Renegotiations

5.4.1 Types of Exogenous Determinants

5.4.1.1 External Environment

The external environment is one of the most relevant exogenous determinants because it encompasses all economic, social and political aspects and also those related to the overall governance of public interest projects, such as the well-functioning of public administration institutions, including the justice system and their major features (e.g., transparency, participation and accountability).

(a) *Socio-economic context*: the impact of the socio-economic context on infrastructure PPPs can occur at several levels. On the one hand, it can affect demand, particularly in those services with higher elasticity (e.g., highways). In the case of healthcare or water consumption, the elasticity is lower. Therefore, the impact is also smaller, even though it can be significant. In other types of infrastructure, namely, those more related to cargo, e.g., seaport concessions, the level of demand is highly correlated with the countries' economic performance, particularly concerning import and export activities. On the other hand, it also affects costs. Higher interest rates imply higher financing costs, or increase in taxes can also negatively affect the concessions'

Table 5.2 Classification of determinants

Exogenous	Endogenous
External environment	Risk sharing agreement
Socio-economic context	Termination clauses
Political context	Re-equilibrium clauses
Political decision bias	KPIs for triggering the renegotiation
Justice system	Contract management clauses
Transparency and accountability	
Public participation	
Force majeure	
Likelihood of repeated business	
Procurement process	
Procurement procedure	
Number of bidders	
Evaluation model	
Financing scheme	
Remuneration model	
Ratio debt versus equity	
Project characteristics	
Investment	
Duration	
Complexity	
Regulatory environment	
Existence of regulator	
Regulatory model	
Contract management	

performance. Issues such as labor legislation and potential labor conflicts might be extremely relevant and impactful on the economic performance of the project.

(b) *Political context*: large infrastructure is particularly prone to political debates and can ultimately be used as political arguments. For example, in Portugal during the 1990s and particularly during the 2000s, the main political parties often engaged in political debates about the need to build a new airport in Lisbon or about the high-speed rail. It was not uncommon for parties in office to argue in favor of a project while questioning the economic merit of projects supported by the opposition. This illustrates the sensitivity of projects to the political context. However, the political context does not solely affect the beginning of the project. Guasch (2004) found a correlation between newly elected politicians and the probability of renegotiating contracts. This is explained by the sensitive and political nature of such projects. When newly politicians take office, it is not rare for them to try to enforce their own ideas to the concessionaire.

(c) *Political decision bias*: there is a generalized and well-documented bias in project appraisal. To justify the project development, politicians tend to overestimate the economic value of the projects, although the technicians preparing the CBA are not immune to criticism. This is reflected in the excessive optimism in revenue forecasts. Baeza and Vassallo (2010) established a cause-effect relationship between the renegotiation of Spanish road concessions and the optimism bias in the demand. Optimism bias is usually noticed very early in the contract and leads to renegotiations during the first years of the concession. This tends to happen more in greenfield projects for which no a priori information exists regarding demand patterns, making it more difficult to perform accurate forecasts. Once the operation starts, it is possible to very quickly assess the accuracy of the initial forecasts. This can also happen because of a political will to increase the rents paid to the government in the short run. Naturally, this effect is very limited in time because the inaccuracy of forecasts eventually becomes evident.

(d) *Justice system*: it is fundamental to have a reliable justice system to allow for quick and fair dispute resolutions. Although other alternatives can, and should, be used, such as mediation and arbitration, the justice system is the ultimate guarantee for solving disputes and making parties comply with the contract. This is particularly relevant when partners fail to achieve a consensus on new terms. If the system does not have reliability, the agents may be forced to accept solutions that they normally would not. Note that a fair and efficient justice system is not only fundamental for administrative issues such as concession contracts but also for the economic environment and confidence of stakeholders.

(e) *Corruption:* corruption is a critical issue in renegotiations. In countries with low levels of transparency and public scrutiny, this may increase the probability of renegotiation and influence the outcomes toward excessive rents for the concessionaire. In fact, this jeopardizes not only the renegotiation process but also the entire cycle of PPP development. In this case, corruption should not be interpreted *strictus sensus* on the legal formulation. It can also represent a form of trading in influence and the absence of incompatibility legislation for those with high level responsibilities in the public sector that after the award of the PPP project shift to the private sector side.

(f) Transparency: the success of any PPP implementation program and, particularly, the success of any renegotiation process are highly correlated with transparency and accountability. Transparency concerns the degree of (free) access to all documents and information of the PPP project, not only those of the initial contract but also all the documents related to the renegotiations that took place and that changed the original contract or created more annexes.
The level of transparency is directly related to the probability of renegotiation and also to the potential impacts of the outputs. In countries with low transparency, it is less likely that the stakeholders will be accountable, and the probability of engaging in renegotiation that does not address public interest

is high. In many countries, particularly Latin countries, there is a high level of secrecy both in the contracts themselves and in the renegotiation processes.

(g) Public participation: a low level of transparency decreases the public participation. Most projects developed under PPP schemes are for the use of the population and generally involve large amounts of public spending. Involving the general population in the discussion of the project is essential to raising support and ensuring that all stakeholders are looking for the maximization of the social welfare, either directly (the public partner) or indirectly (the private partner). To allow for this public participation, it is essential that most supporting documents for the project are made available. These documents should cover all the main stages: the initial decision (CBA), the adoption of the PPP model (PSC), the choice of the business model (economic and strategic studies), and the operation stage (monitoring reports), to cite the most relevant documents. The possibility of including non-technical summaries should also be considered for those less familiar with the subjects to ensure that the general population can understand key issues. The existence of formal public consultation, such as public hearings (e.g., before parties signing the contract), might be a sound practice if they are quick and do not delay the PPP implementation process too much (e.g., see the example of Brazil).

(h) Accountability: accountability concerns the obligation for individuals or entities to answer and take full responsibility for their actions. This should not be understood simply from a legal perspective but from an overreaching ethical and good governance perspective. All decisions with a long term impact on society, such as most PPP projects, should be scrutinized, and the political and technical decision makers should be accountable for the decisions made. In most countries with large PPP programs, this has been highly discussed. Generally, this happens when contracts have to be renegotiated and the public sector needs to assume large financial responsibilities because of the original design of the contract. What should be the responsibility of those political decision makers, even when they are no longer in office? In addition to the legal and criminal responsibility, accountability is also related to ethics and honesty principles. However, it is very difficult to ensure accountability if transparency and public participation are not guaranteed. The higher the levels of transparency and public participation, the more accountable the decisions will be, notwithstanding formal and institutional mechanisms to ensure accountability.

(i) *Force majeure:* these events usually have a low probability of occurrence, although some regions in the world are more vulnerable to hurricanes, earthquakes or volcano eruptions, just to mention some examples. However, the impact of these events is extremely negative and might, in some cases, even permanently destroy the infrastructure. Recent examples such as the 2011 tsunami in Japan or Hurricane Katrina in the US caused severe damage to most water, transportation and energy infrastructure. Because of the very high impact of these events, they are usually not insured against. This is a very

relevant issue. In cases where these events happen, the concessionaire will be in a delicate situation. The reestablishment of this infrastructure is critical and necessarily implies cooperation between both parties to minimize the impacts of the disruption.

(j) *Likelihood of repeated business:* from a private sector perspective, future actions will be conditioned by the expectation of future (repeated) business. If the private partner expects to engage in future business, its actions will try to minimize potential conflicts that might jeopardize its reputation. The literature on psychological economy defines this phenomenon as "reputation mechanisms" (see more in Fombrum 1996; and Curhan et al. 2006). When there is the expectation of developing more projects within the same sector or country, the private partner may be willing to accept reasonable losses (during renegotiation or avoiding it), hoping for future gains without jeopardizing its reputation. However, if there are no expectations of developing new businesses in the area, the concessionaire might assume a more peremptory position during renegotiation.

5.4.1.2 Procurement Process

(a) *Procurement procedure*: there is a wide variety of models to award a concession, ranging from a direct award to competitive bidding, incorporating several distinct features, for example, with or without a negotiation phase. From the perspective of renegotiation probability, it is important to distinguish between the processes with competition and without competition. In cases where there is competition, phenomena such as the "winners' curse" or "aggressive bidding" (Hong and Shum 2002; Ubbels and Verhoed 2008; Baeza and Vassallo 2010) might occur and increase the probability of renegotiation. In fact, the likelihood of these phenomena can be correlated with the number of bidders.

(b) *Number of bidders*: the link between the number of bidders and the probability of renegotiation is due to the strategic behavior by competitors (underbidding to obtain the concession) or the effects of the winners' curse (Guasch 2004; Hong and Shum 2002; Ubbels and Verhoed 2008). When the number of bidders is excessive, it increases the likelihood of aggressive bidding. Aggressive bidding happens when the concessionaire is willing to accept losses in the short run, expecting to break-even in future renegotiations. To do this, the concessionaire needs to consider in two things: first, the probability of existing renegotiation in the medium term is high and, second, the outcome of the renegotiation has to be favorable. Later on in this chapter, the patterns for renegotiation will be presented, but there is clear evidence that these two aspects are extremely likely to happen. However, when the number of bidders is very low, there might not be enough competitive pressure, which will decrease the VfM of the proposals. Although less likely to induce future renegotiation, it is not a desirable outcome for the public sector. A high number of bidders might influence the probability of renegotiation, but a very low number of bidders may also bring other types of problems.

(c) *Proposal evaluation model:* simplistically, one may argue that a PPP can be awarded either directly to a private entity or through a competitive procedure, as discussed earlier. In the case of a competitive procedure, it is necessary to define an evaluation model to assess each proposal and identify the best possible alternative. This model usually has several evaluation criteria, for example: NPV, technical quality or financial robustness. When the evaluation model for selecting the best bid is excessively dependent on NPVs, it can allow for aggressive bidding (as referred to earlier) and, therefore, increase the probability of renegotiation. The evaluation model should address the public sectors' objective function, selecting criteria and weights that will ensure the highest VfM possible. However, the use of too many criteria (and subcriteria) increases the transactions costs and might unduly favor the discretionary spending of the governments in the evaluation.

5.4.1.3 Financing Scheme

(a) *Remuneration model:* there are several models for remunerating the concessionaire, but they can be summarized by two schemes: user charges (or payments linked to the demand) and availability (or rent) schemes. In the first case, considering the problem of optimism bias in demand forecasts, the likelihood of renegotiation increases. In availability schemes, the grantor retains the demand risk and, therefore, eliminates a large source of risk for the concession, thus decreasing the probability of renegotiation.

(b) *Ratio debt* versus *equity:* usually the percentages of debt and equity are approximately 70 % and 30 %, respectively. Because the required investment is very high, the percentages of debt are also high, in some cases approximately 90 %. Nevertheless, it is important to ensure that there is a proper level of equity involved. One can argue that this equity is the VaR for the private partners. Therefore, the higher is their VaR, the more interested they are in the project success. This may have implications in controlling the construction costs, operating costs, i.e., delivering a solution with a higher VfM. This is the main reason why it is necessary to have a significant share of equity in the portfolio of financing sources. Nevertheless, the uncertainty surrounding debt is high. When the level of debt is very high, the concessionaire is more exposed to external financial market uncertainty. The Euro sovereign debt crisis showed that this uncertainty is high and can have severe implications in renegotiation. In some countries, several projects have been renegotiated because of increases in financing costs.

5.4.1.4 Project Characteristics

(a) *Investment:* most PPP projects require intensive capital. Frequently, they also involve sunk assets and a huge up-front investment. The construction of roads, hospitals, dams or power plants, for example, requires a large and sunk investment. Furthermore, the high levels of investment of this infrastructure are one of the primary reasons for adopting the PPP model, as mentioned earlier. The higher the investment, the higher is the uncertainty related to cost overruns and

delays, and therefore, the more likely it is that renegotiation occurs. The uncertainty related to the construction phase is solved within the first years of the concession. This is one of the reasons why renegotiations tend to happen in the first years.

(b) *Duration:* the longer the contract, the higher is the exposure to uncertainty. Contracts are generally long, and in theory, the duration should be proportional to the investment to allow the concessionaire to recover the full costs. When the contract is awarded, it is necessary to have forecasts for the entire duration of the project (costs, demand, macroeconomic context, etc.). Therefore, the likelihood of renegotiation will increase for longer contracts.

(c) *Complexity:* the complexity of projects is usually measured by the technical difficulty in building or operating the infrastructure. It is much more complex to build a tunnel for several kilometers than a hospital building. The complexity in the first case leads to a higher risk. The process of tunnel building is technically extremely complex, and there is a very high degree of uncertainty in relation to the geotechnical, geological and archaeological conditions. Thus, in this type of project, cost overruns are more likely to be found. The higher the degree of complexity in the construction, the higher is the probability of renegotiation. In addition to the complexity of building, there is also the complexity of operating. The operation of a light rail system is more complex than the operation of a toll-free highway. In the latter case, the operation consists in normal maintenance activities and in accident teams. However, the operation of a light rail system involves more risks that increase the complexity of the process.

5.4.1.5 Regulatory Environment

(a) *Existence of regulator:* the need to develop projects has led governments to launch PPP arrangements without the definition of an adequate and independent regulatory agency with the aim of supervising and supporting the design, launch and monitoring of PPP projects. The lack of this referee perspective decreases the transparency. The regulator works for the public sector as a for-free consultant, and for the private sector, it is a guarantee of the non-existence of the populist and political interference in the PPP project. Furthermore, when the same public agency is responsible for the preparation of the bidding process, selecting the winning bid, designing the contract and contract management, it cannot be a referee when there are conflicts. The absence of a regulator thus increases the likelihood of renegotiation, as demonstrated by Guasch (2004).

(b) *Regulatory model:* the existence of a regulator is not a sufficient condition to ensure that the VfM is maximized. It is necessary to design and implement a regulatory model with effective mechanisms to protect the public interest. The more adequate the regulatory model, the lower the probability of renegotiation will be. However, this only happens if this model is in place before the award procedure starts to comply with the regulator recommendations. There are several regulatory models, each one with particularities and adaptations to each country's specificities. Nevertheless, the economic regulatory methods adopted can be categorized into two general types: price cap and rate of return

regulation (Marques 2005). Price cap regulation, as the name suggests, is a form of regulation where a cap for the prices or revenues is established by the regulator. This cap is usually based on the CPI subtracted by an expected productivity gain (X). The X value intends to provide an incentive for productivity improvement. In contrast, rate of return regulation focuses on costs instead of prices. The regulator allows the operators to earn a return on the investments made. The regulator, by taking into account the business risk profile, determines the rate of return. The riskier the business, the higher the rate of return will be.

(c) Contract Management
The absence of an explicit contract management structure has a direct impact on the probability of renegotiation and on the outputs of the process. The lack of a governance structure for these projects jeopardizes the public sector's ability to protect the public interest.

5.5 Endogenous Determinants for Renegotiation

5.5.1 Types of Endogenous Determinants

5.5.1.1 Risk Sharing Agreement

The risk sharing agreement is highly correlated with the vulnerability for renegotiation, although in distinct ways. The risk sharing agreement contains the allocation of risks. Some are retained by the public sector, others are transferred into the private sector and some can be shared.

One may argue that when most risks are transferred to the concessionaire, the probability of renegotiation is low considering that the concessionaire has accepted to "live" with the contract terms, so, if the reality is worse than planned, he has to live with that contract. Theoretically, this is true, but the reality is far more complex because of government bailouts. This has often occurred in Latin America. When the concessionaire is struggling to survive, it asks for a renegotiation of the contract to incorporate the new unveiling conditions. Because of the sensitive nature of public services and to avoid service disruptions or any instability, the governments engage in these renegotiations.

In many cases, both partners share the risk, e.g., demand risk. A very popular model among road and railroad concessions is the "band system". It establishes demand levels that serve to determine the payments to the concessionaire and also defines a minimum level for the demand. If the demand does not reach this level, then the concessionaire might ask for a renegotiation. In theory, the system seems to minimize the risk of renegotiation to those very pessimistic scenarios. However, this argument fails because of the excessive optimism in fixing this minimum level. This has happened extensively in many Italian, Spanish, and Portuguese concessions.

5.5.1.2 Termination Clauses

Termination clauses are only used as a last resource when the renegotiation does not provide any solution. Nevertheless, they should be carefully designed. Most termination clauses provide an unfair protection to the concessionaire. One may argue that this avoids predatory behaviors by the government. The concessionaires have made large sunk investments and should be protected.

However, by overprotecting the concessionaire, he is given a large bargaining power over renegotiation because the government does not have any leverage. The termination of the contract can be achieved by a unilateral contract recapture by the government or by a consensual termination.

In each case, the compensation has to be determined differently. In the first case, the concessionaire will have the right to what is established in the contract, which, in many cases, includes the sum of all expected earnings (profits) until the end of the contract plus the value of non-depreciated assets and debt charges. This usually ends up with very high values. In the second case, this will be determined by the agreement that both parties reach.

5.5.1.3 Re-equilibrium Clauses

In some countries, contracts include re-equilibrium clauses, i.e., predefined rules to restore the economic and financial equilibrium in the OBC.[2] These rules often define intervals for some key financial indicators (e.g., IRR or DSCR). These rules influence the final result of the renegotiation process. If the intervals are very small, the concessionaire will be protected in the renegotiation process because his financial performance will not vary. This is often the case. This issue will be detailed later.

5.5.1.4 KPIs for Triggering the Renegotiation

It is possible to find KPIs with a corresponding tolerance interval in some contracts that when exceeded, allow for each partner to open the renegotiation process. These KPIs can be related to demand or can have a financial nature (e.g., IRR or DSCR).

5.5.1.5 Contract Management Clauses

The non-existence of specific contractual clauses regarding the contract management process will influence both the probability of renegotiation and its outputs. One of the main objectives of contract management is to decrease the problem of information asymmetry. In the absence of adequate information, it is not possible to verify the events/causes for one of the parties to ask for a renegotiation, leading to opportunistic behavior. However, even during the renegotiation phase, the absence of information jeopardizes the ability to discuss and negotiate the new terms. The strategic behavior of concessionaires, discussed earlier, is strongly discouraged if

[2] The OBC is a spreadsheet with all expected costs and revenues for the contract duration. It contains the forecasts of demand (that will determine the revenue) as well as the cost estimation (construction, maintenance, operation, finance, among others).

there is the perception that PPP contracts are being correctly managed by the public sector, which is not the reality in most cases. By preventing this behavior, contract management can reduce the probability of renegotiation.

5.5.2 Contractual Triggers for Renegotiation

5.5.2.1 Type of Contractual Triggers

Particularly in Latin countries, it is possible to find a set of KPIs in contracts whose main purpose is to establish conditions that allow for the renegotiation process to start. Some examples were already given in the previous section, but these triggers are not exclusively KPIs. Other examples are the unilateral changes to the investment plan (e.g., new works), the operating conditions, the levels of quality of service or any other variation to what is stated in the initial contract whose responsibility is not assigned to the concessionaire in the risk matrix (e.g., new legislation). All these contractual clauses are defined as "contractual triggers", for which two classifications should be adopted according to their nature: qualitative and quantitative.

5.5.2.2 Qualitative

As mentioned above, qualitative triggers are not associated with any KPIs but rather with actions or contractual changes. The most typical example is the unilateral contractual changes, which can be of different types:

- Scope: changing the concession scope, both the object of the concession and its scope;
- Investment plan: changing the investment plan (increasing or reducing the works);
- Legal: changes in the legal framework;
- Indirect services: changes in the price or conditions of services provided directly to the concessionaire and under the responsibility of the government (e.g., water wholesale services in drinking water concessions or the price of fuel in waste collection or energy services); and
- Prices: changes in the price of the service (e.g., unilateral decision by the government of decreasing the tolls in a road concession).

Note that these qualitative factors might (and should) be associated with quantitative triggers.

5.5.2.3 Quantitative

Quantitative triggers are KPIs with numeral metrics and can be divided into two different types: key inputs of the concession and economic and financial variables of the concession.

Key Inputs of the Concession

The key inputs of the concession are variables not controlled by the concessionaire that might impact on the economic performance of the concession. Among them, two are particularly relevant: demand/consumption and interest rates (financing costs).

The first variable, demand/consumption, is most likely the most critical factor for the success of a concession. In roads, the demand might be measured by the number and type of vehicles; in urban transport systems, it might be quantified by passengers or passengers.kilometers; in drinking water systems, it might be measured by the volume of water consumed; in waste management systems, it can be the weight and type of waste treated; and in health care systems, it may be number and type of health treatments. These are related to the revenue forecasts.

Another type of key input variable is the cost of capital. Many financing arrangements have as a reference the Euribor rate. The volatility of this variable is not controlled. Finally, another key input variable is the value of taxes that can be changed across time.

Economic and Financial KPIs

These types of KPIs are related to the internal economic and financial performance of the concession. Some common examples are the IRR, DSCR or the loan life coverage ratio (LLCR). These KPIs are not independent from the "key inputs of the concession" because any variation, for example, in the demand, will affect the revenues and, consequently, the IRR.

It is relevant to ask why another set of indicators that are not independent from the previous one should be developed. The fact is that there is a certain degree of redundancy. This can be explained by the fact that there are events that may interfere with economic and financial KPIs, which are not key inputs of the concession. The most common example is unilateral changes from the government. If those changes result in, for example, increasing (or decreasing) the investment, then the effect of the action will be detected by these KPIs.

5.5.3 Discretionary versus Contractual Renegotiation

5.5.3.1 Discretionary Renegotiation

After the renegotiation is initiated, how is the renegotiation process managed? Different alternatives are possible. One alternative is what the authors define as discretionary renegotiation. Under this model, both agents try to establish a common understanding on the new terms of the contract without any a priori limitation. There are no established rules, and the agents are expected to reach a common understanding. Ideally, this requires supervision from a regulatory agency to ensure that the new contract safeguards public interest.

Discretionary renegotiation requires particular attention from a transparency perspective. It is very vulnerable to the problem of "agent capture". The public servants representing the public sector might be exposed to lobbying, if there are not attempts of corruption, by the private sector. To decrease this risk, it is

necessary to make the process as transparent as possible. Participation is also a major issue. This means making the objectives, restrictions and outcomes of the renegotiation process publicly available. In fact, it should go a step further in allowing the general public to have access to the minutes of the meetings between the public and the private sector. It should also include public hearings before the new terms are signed. This would allow for a public participation, which increases the scrutiny over the process, thus decreasing the likelihood of negative outcomes.

5.5.3.2 Contractual Renegotiation

Another alternative is defined, according to the authors' term, as contractual renegotiation. In this case, a set of a priori rules are established in the contract, which provide a guideline for the renegotiation process. Unlike the discretionary renegotiation where the agents have all the degrees of freedom to agree upon the new terms, in this case, the outcome of the renegotiation process is somehow limited. This model has been used in several countries (e.g., Portugal).

What are those rules? The KPIs mentioned earlier used to trigger the renegotiation process are now used to set the outcome. For example, the initial contract states that the IRR should be kept the same in any renegotiation. The final outcome of the renegotiation needs to ensure that the IRR is the same. However, the OBC should only be changed with respect to the consequences that the event that motivated the renegotiation had on the structure of costs and revenues, and no advantage should be taken out of this circumstance to change the risk matrix and recover some of the costs under the concessionaire's responsibility.

This renegotiation process does not require a deep regulatory intervention because the rules are pre-established and shared by both agents. However, if these rules are not "reasonable", the renegotiation processes will be negatively conditioned until the end of the contract. This model provides some theoretical advantages because it allows dealing with the incomplete nature of contracts. It is impossible to forecast all possible contingencies. Therefore, the agents define a priori the framework to manage the renegotiation process.

As mentioned before, some contracts have incorporated a set of pre-established rules to manage the renegotiation process. These rules are generally based on a set of economic and financial KPIs associated with an interval of variation (usually small) that cannot be jeopardized by the renegotiation outcome. This is generally referred to as the EFR model (Cruz and Marques 2013f).

5.5.4 The EFR in Concessions: Practical Examples

Several countries have some tradition of applying the EFR model in PPP projects.

Table 5.3 presents a summary of the main clauses for EFR applied in Portugal in several sectors.

One of the main problems of the EFR model is that irrespective of its merits in dealing with contract incompleteness, the intervals for the KPIs are far from reasonable. In the case of the roads and water sector, the IRR or DSCR can only

Table 5.3 Summary of clauses for EFR

Sector		Rules for EFR	State level
Transportation	Roads	The concessionaire can ask for renegotiation if there is a 0.01 % decrease of the following indicators:	National
		DSCR	
		LLCR	
		Shareholders' IRR	
	Railways/ light rail systems	The impact of those events is measured by a decrease of 0.03 % of one of the following ratios:	National/ local (light rail)
		DSCR;	
		LLCR;	
		Shareholders' IRR	
	Ports	Renegotiation should be agreed between the two parts[a]	National
Health		In the first case, the decrease in the shareholders' IRR has to be above 0.5 %, while in the second case, the reduction is only 0.1 % and not just in the shareholders' IRR but also in the DSCR	National
Water and wastewater		The concessionaire can ask for renegotiation if there is a 0.01 % decrease on the following indicators:	Local
		DSCR	
		Shareholders' IRR	
Energy		Renegotiation should be agreed on between the two parts	National

Source: Cruz and Marques 2013f
[a]Only one contract out of five has quantitative rules: reduction higher than 0.03 % in DSCR, 0.05 % in LLCR or 0.1 % shareholders IRR

vary 0.01 %. Naturally, considering the large investments in these projects, any small deviation can trigger the renegotiation process.

Most contracts state the events able to trigger the renegotiation process, which are (Cruz and Marques 2013g) any unilateral change made by the government with negative impact on the revenues and/or costs; *Force majeure*; legal changes affecting the revenues and/or costs; and when the right to renegotiation is clearly stated in the contract (for example, regarding ridership forecasts, there is a lower limit below which renegotiation is allowed). When the impact of any of these events affects the KPIs by more than 0.03 %, then, the concessionaire can ask for contract renegotiation.

5.6 Renegotiation Main Patterns

As mentioned in the literature review section, there are few studies presenting real data from renegotiation patterns. We will focus on two studies: Guasch (2004) and Cruz and Marques (2013b).

Table 5.4 Infrastructure concessions in Latin America

	Telecommunications	Energy	Transportation	Water and wastewater	Total
Total	273	256	276	137	942
Share	28.9 %	27.1 %	29.2 %	14.55	100 %

Source: Guasch 2004

Guasch (2004) gathered data from 1,000 concessions in the Latin American and Caribbean region awarded between 1985 and 2000. Cruz and Marques (2013b) collected data from 87 projects in several sectors such as transportation (roads, rails and ports), health, water supply and energy (distribution and production). These data included concessions granted by the central government (1984–2008) and by municipalities (water and wastewater) and are described in Tables 5.4 and 5.5.

The data from Guasch (2004) show that the energy sector has the lowest renegotiation rate (9.7 %), which is far lower compared with the remaining sectors. For example, the water and wastewater sectors have a rate of 74.4 %. The data from Cruz and Marques (2013b) are consistent with this conclusion, though the average values are higher. The energy sector has the lowest renegotiation rate (19 %), and the water and wastewater have the highest (100 %) (Table 5.6). The transportation sector has similar renegotiation rates, slightly above 50 %. The health sector has a renegotiation rate of 20 %, but the low number of concessions (only five) and the small amount of time since the projects were awarded require some caution on drawing conclusions. In the transportation and water and wastewater sectors, the renegotiation rates seem excessive, and they are actually higher when looking at the average time between the time of the award and the time of the first renegotiation.

It is important to remember that most infrastructure concessions have long durations – frequently above 25 years. In the transportation sector, Guasch (2004) found that contracts are renegotiated, on average, 3.1 years after the award. Cruz and Marques (2013b) found similar results, 3.3 years. However, in the water and wastewater sectors, this value drops to 1.6 and 1.5 years. Table 5.7 presents the results of the analysis.

This raises several important questions. Contracts established for some decades quickly become obsolete and require major revisions. After the first couple of years of the concession, particularly for greenfield projects, two of the most important risks are severely mitigated (demand risk and construction risk). An early renegotiation might be required if it adapts the contract to unveiling situations regarding demand and construction. The problem is that besides being renegotiated at a very early stage, the concessions are quite often renegotiated.

Looking at the data from Cruz and Marques (2013b), the average number of renegotiations in transportation is 2.0 and 1.69 in the water and wastewater sectors. The same authors show that in these sectors, contracts are renegotiated when the contract completion is at 13 % and 5 %, respectively.

The renegotiation process usually starts because one agent, or even both agents, do not want to live with the existing framework provided by the contract. Therefore, each agent, or both simultaneously, can require renegotiation. This is the

Table 5.5 Infrastructure concessions in Portugal

	Energy	Transportation	Water and wastewater	Health	Total
Total	16	37	29	5	87
Share	18.4 %	42.5 %	33.35	5.7 %	100 %

Source: Cruz and Marques 2013b

Table 5.6 Percentage of renegotiated contracts

	Energy	Transportation	Water and wastewater	Health	Total
Guasch (2004)	9.7[a]%	54.7 %	74.4 %	n.a.	30 %
Cruz and Marques (2013b)	19 %	51 %	100 %	20 %	67 %

[a]Only consider the electricity sector

Table 5.7 Average time from the award to the first renegotiation

	Energy	Transportation	Water and wastewater	Health
Guasch (2004)	n.a.	3.1	1.6	n.a.
Cruz and Marques (2013b)	15	3.3	1.5	1.0

renegotiation initiator. Both studies are consistent in showing that most renegotiations are initiated by the private sector (operator) (Table 5.8).

The fact that the majority of the renegotiation processes takes place upon the operator's request allows the foresight that the outputs of the process often benefit the private sector. The renegotiation process can have several outcomes. The most usual are:

- Changes in the contract scope;
- Decrease in royalties;
- Lump-sum payments from the grantor;
- Tariff increases;
- Increase in the concession duration;
- Delay in investments; and
- Tax benefits.

Often, the final outcome incorporates a mix of the above-mentioned outcomes. Guasch (2004) found that the most frequent outcome of the renegotiation process is the delay in investment obligations, followed very closely by tariff increases and the reduction of investment obligations. Table 5.9 presents the results of Cruz and Marques (2013b).

The preferred mechanisms in Portuguese renegotiations are direct payments from the government to the concessionaire (mainly in roads) and an increase in tariffs (particularly in the water and wastewater sectors). The contractual renegotiation model adopted restricts these outcomes. In road contracts, it is stated that the concessionaires' IRR cannot change. Therefore, when some event, for example, the government changing the road layout, implies more costs, it is necessary to quickly act on the revenue side by providing direct payments.

Table 5.8 Share of the initiator of renegotiation in percentage

		Energy	Transportation	Water and sanitation	Health	Total
Guasch (2004)	Both		16	10		13
	Government		27	24		26
	Operator		57	66		61
Cruz and Marques (2013b)	Both		5.8	4.1		3.5
	Government	100	17.6	6.1	100	14.1
	Operator		76.4	89.8		82.4

Table 5.9 Renegotiation outputs

	Direct payment[a]	Tax benefits	Changes in contract scope[c]	Contract extension	Contract reduction	Increase in tariffs for final users	Decrease in rents	Delay in investments
Transportation								
Roads	23	1	1	1				
Rails	4		1		1			
Ports				1			1	1
Health	1[b]							
Water				6		41	2	
Energy						4[b]		
Total	31	1	2	2	1	45	1	1

Source: Cruz and Marques 2013b
[a]Lump sum or annual payment
[b]In dispute
[c]With cost reductions for operator

In water and wastewater concessions, the usual outcome is a tariff increase, although there are some cases where contract extensions were given. The preference of municipalities for "non-direct compensation" methods can be explained by two reasons. First, municipalities have a smaller financial "cushion" when compared with the government and thus less availability for lump sum payments. Second, the price elasticity of demand for water services is significantly lower than, for example, tolls in highways or fares in commuter rails.

Table 5.10 presents the main outcomes of renegotiation processes in Latin America.

In Latin America, as mentioned before, the main outcome observed was delays in investment, followed by tariff increases and a reduction in investment obligations. The data show that most renegotiations are far more advantageous to the concessionaire than to the public sector. For instance, the adjustments in annual fees or changes in the asset-capital base are generally favorable to the operator. Even delays in investments or a reduction in investment obligations are advantageous to the operator. Table 5.11 presents the main causes of renegotiations in Portugal by sector.

Table 5.10 Outcomes of the renegotiation process in Latin America

Renegotiation outcome	Percentage of renegotiated concession contracts
Delays in investment	69
Acceleration of investment	18
Tariff increases	62
Tariff decreases	19
Increase in costs with automatic pass-through to tariff increases	59
Extension of concession period	38
Reduction of investment obligations	62
Adjustment of annual fee	31
Favorable to operator	17
Unfavorable to operator	
Changes in the asset-capital base	46
Favorable to operator	22
Unfavorable to operator	

Source: Guasch 2004

There are relevant differences among the several sectors. For instance, in the transportation sector, the unilateral changes imposed by the government, either directly through the grantor agency or indirectly due to other agencies (e.g., environment), are the main reason for renegotiations. Conversely, in the water and wastewater sectors, the large majority of renegotiations are due to optimist bias in the forecast. The real consumptions are far below the original estimates, thus leading to renegotiation.

The changes in the projects' design should be categorized into two different classes. Some changes are imposed by the grantor agency, for example, the ministry of transportation deciding to change the road layout or the location of rail stations. The ministry of environment, for environmental reasons, requests the second type of changes. When these changes are made after the contract is signed, they represent unilateral contractual changes by the public sector and consequently give the concessionaire the entitlement to a renegotiation. In Portugal, this has been more frequent than desirable. During the late 1990s and early 2000s, many contracts were signed before environmental permits were obtained. This led to high compensations paid to concessionaires.

The same happened with expropriations. In the road sector, the risk associated with expropriations was shifted, over time, to the private sector. Until the mid-2000s, this was a risk entirely managed by the public sector, which was unable to deliver the land on the pre-determined milestones. The concessionaires asked for a renegotiation and were generously compensated.

In the water and wastewater sectors, the main cause for renegotiation is the optimism bias in demand forecasts. One should ask why the forecasts always fail. Several reasons can be found, but the main reason was because of the need to obtain positive NPVs. The municipalities prepared forecasts that were later integrated in

Table 5.11 Main causes for renegotiations by sector

	Changes in design		Demand bellow forecast	Delays in expropriation	*Force majeure*	Competition issues	Additional inv./costs	Excessive market power
	Grantor	Other agencies						
Transportation								
Roads	9	5	2	4	1	1[b]		
Rails	3		1	1				
Ports			2				1	
Health	1[a]							
Water	3[c]		24					
Energy								1
Total	16	5	29	5	1	1	1	1

In some cases, the process of renegotiation was due to more than one reason
Source: Cruz and Marques 2013b
[a]A concession tender was launched incorporating a road section that was already part of an operating concession
[b]The changes did not directly regard the physical infrastructure but the portfolio of medical services provided
[c]Changes were related to the services provided (ex: exclusion of wastewater treatment), with implications in infrastructure design and investment

the bidding documents that made the projects more attractive than they truly were. For the private sector, this did not represent a problem, even though most stakeholders were aware of this "optimism" because soon after, they required a renegotiation of the contract because of explicit failures in the forecasts.

Force majeure or competition issues are far less frequent but can also occur. The *force majeure* renegotiation was due to strong rain that resulted in delays, while competition issues were invoked because of road section overlapping. Both in the health sector and in the energy sector, the level of renegotiations are lower. In the first case, the contracts are relatively recent, and therefore, it is still too soon to draw reliable conclusions. In the second case, the concessions have worked on a stand-alone basis, and this type of concession has shown a lower level of renegotiation (the same happens in seaport concessions).

As mentioned earlier, is not uncommon for renegotiations to result in higher costs for the government. Nevertheless, it is necessary to understand what was renegotiated to understand the true nature of the costs. When there are increasing costs without any change in the concession object, it is clear that the process simply results in cost increases. This happens when the renegotiation is related to increases in capital costs.

However, it is entirely different when there are changes in the object of the concession, the investment plan and/or the services provided. In these cases, to determine whether the renegotiation had a positive or negative impact from a social welfare perspective, it is essential to determine the corresponding benefits. Taking the case of a road concession whose contract was renegotiated by the government due to a change of the location of a road exit, the concessionaire claimed

Table 5.12 Costs of renegotiation of roads and rails in Portugal

(million Euros)	Roads	Railways	Total
Claims	1,912.06	113	2,025.06
Agreements	666.6	45.18	711.78
In dispute	521.02		521.02
Total	3,099.68	158.18	3,257.86
Governmental payments	16,527.30	322.70	16,850.0
(Relative weight)	(18.8 %)	(49.0 %)	(19.3 %)

Source: Cruz and Marques (2013b)

compensation to address the costs of such a change. For the government, there is a clear cost – the compensation paid.

Notwithstanding, the change might bring benefits. For example, the road exit is now located next to a large industrial plant, or the modification protected an environmentally sensitive area. This hypothetical example illustrates the need to take into account for both the benefits and costs of these changes. To evaluate the cost of the renegotiation for the government, it is necessary to simultaneously address the benefits. This requires a level of data that usually is not available.

Table 5.12 presents some data on renegotiation costs (claims, agreements and disputes) for the road and rail sectors.

The costs of renegotiation are significant, particularly when measured as a percentage of the contractual governmental payments stated in the original contract – 18.8 % in roads and 49 % in railways. For the latter, the overrun was essentially due to one concession – Fertagus, a commuter rail service in Lisbon – which was planned not to have any burden on the government, but the government was burdened with significant payments to ensure the economic and financial equilibrium of the concession. This was essentially due to optimism bias in the traffic.

5.7 Cooperative Renegotiation

Although the pattern for renegotiations in concessions seems to lead to a systematic negative impact on social welfare (as the next section will clarify), there are cases where in fact, the process of renegotiation solved contractual flaws, benefiting the public.

When parties expect to engage in future contracts, they are more likely to engage in renegotiations where the government can gain some value or limit its losses (Brux 2009). The rationale is that renegotiations are not always led by the opportunist behavior of one of the parties but can actually result from a common desire to restructure a contract that is performing poorly and should no longer be in force.

Based on the evidence provided earlier, this is not the typical pattern among Portuguese renegotiations. Nevertheless, this behavior can be found. The first PPP in a commuter rail, the Fertagus concession over the Tagus River, is an example of cooperative renegotiation. The concession, signed in 1999, was first designed to

require no public subsidy from the government for 30 years. The underlying scheme for the revenue risk sharing was a system of bands. Above the upper limit, the concessionaire would share those additional revenues with the government, and below the lower limit, the government would compensate the concessionaire.

Four years later, in 2003, the government had already paid more than 100 million euros of subsidies because of the excessive optimism in traffic revenues. The contract still had 26 years ahead of it, so social welfare was seriously jeopardized. In 2004, the contract was renegotiated again. The government bought back the rolling stock, leasing it back to the concessionaire, thus eliminating the capital costs. The length of the contract was reduced. Initially planned to end in 2029, it would now end in 2010, and traffic forecasts were updated with real data from the first years of operation. The changes also affected the revenue risk, transferring it to the concessionaire. Globally, the IRR dropped from 10.89 % to 7.76 % (Court of Auditors 2005).

In the first years of operation, the excessive subsidies given to a concession that was supposed to operate on a stand-alone basis gave rise to public contestation and a general opinion that the concessionaire was being overpaid. The expectations were to develop more concessions for the commuter rail. Acknowledging that a negative first experience could jeopardize the entire privatization program for commuter rails, the renegotiation was envisaged by both parties as an opportunity to develop a contract more likely to maximize social welfare.

Even though this is not the common *modus operandi* of renegotiations, it might in fact be the only case where the operator was worse off after the process, and "reputation" might have played an important role. However, this was not "altruistic" behavior by the concessionaire. The negative perceptions toward the contracts could jeopardize (politically) the plan of increasing private sector participation in railway services in Portugal, which was not in the concessionaires' best interest.

5.8 Main Determinants of Renegotiation: An Empirical Analysis

In the earlier sections on this chapter, the authors theoretically discussed what drives renegotiation and the several types of determinants that can influence the probability of renegotiation and its main outcomes. It is now time to look into real data and try to identify the main determinants of renegotiation.

Guasch (2004) and Cruz and Marques (2013b) shed some light on the determinants behind a contract's probability of renegotiation. Although the variables tested in each study are not exactly the same, with some exceptions, they allow for reasonable consistent conclusions. Both studies used a probit analysis, defining the probability of renegotiation as the dependent variable.

Guasch (2004) tested the following determinants: macroeconomic shocks, award criteria, investments, competition in the award process, existence of a regulator, autonomy of a regulator, type of regulation, nationality of the

Table 5.13 Summary of the main conclusions of the empirical analysis

Guasch (2004)	Cruz and Marques (2013b)
The existence of a regulator decreases the probability of renegotiation	Concessions with higher investments and longer durations are more likely to be renegotiated
Rate-of-return regulation decreases the probability of renegotiation	More experienced regulatory agencies decrease the probability of renegotiation
Awarding contracts based on the lowest tariff increases the probability of renegotiation	The existence of a regulatory agency when the contract was signed decreases the probability of renegotiation
Competitive bidding increases the probability of renegotiation	Awarding under competitive procedures increases the probability of renegotiations
After elections, the probability of renegotiation increases	

concessionaire, electoral cycles, source of finance, prior concessions, length of concession and corruption.

Table 5.13 presents the main conclusions of the empirical analysis performed by both studies.

Most conclusions are expected and consistent across studies. The regulatory enforcement assumes an important condition to decrease the probability of renegotiation, as expected. This raises relevant concerns because most countries developing these projects either do not have proper regulatory agencies in force or have agencies recently created with no accumulated know-how and expertise. In the long run, this can jeopardize public interest. The simple existence of a regulator is not sufficient. The problem of regulatory capture is well known, and to avoid it, it is necessary to have independent (managerial and financial) agencies.

Another relevant conclusion concerns the type of award procedure. It was found that competitive procedures increase the probability of renegotiation. The reason might be related to problems such as the "winners' curse" and aggressive bidding. Aggressive bidding is more relevant when the competitive pressure is higher but particularly when the award criteria are excessively dependent on the final NPV. With a high probability of renegotiation, as demonstrated by the real renegotiation rates presented in this chapter, the concessionaires can engage in proposals that represent economic losses, expecting to reach an advantageous return in the renegotiation.

Finally, it should be highlighted that poor or non-existent contract management considerably weakens the public sector in all the renegotiation processes. As will be discussed in section 4 of this book, a sound and appropriate contract management can anticipate and mitigate the effects of renegotiation (and, at the limit, avoid it). Furthermore, it reduces the existing asymmetric information and the consequent power of the concessionaire in renegotiation bargaining. By endowing the public sector with more information and knowledge about the PPP contract and its performance, it becomes better prepared to face the arguments of the concessionaire.

5.9 Minimizing the Probability and Impact of Renegotiation

Considering the average results of the renegotiation process from a public policy perspective, one can claim that a renegotiation is a risk for the public sector. After the renegotiation process, the public sector is generally worse than before it started.

Therefore, to mitigate this risk, the public sector can follow two separate paths, either decrease the probability of renegotiation or decrease the negative impact of the renegotiation outcomes.

Most alternatives that will be presented next have effects on both parameters.

5.9.1 Flexible Duration Contracts

Flexible duration contracts are not new and have been used in some countries, for example, the Santiago – Valparaiso highway (Route 68) in Chile, the first LPVR concession developed in this country. The principle is to mitigate the exposure to the demand risk. Because the concessionaire's return is indexed to the accumulated volume of traffic, the contract duration is a function of this variable. If the traffic volumes are lower than expected, the contract will be longer, and if the volumes are greater than anticipated, the duration will be shorter. Some authors (Engel et al. 1997; and Albalate and Bel 2009) argue that this model allows for controlling the excessive rent appropriation by concessionaires while decreasing the public sector exposure to demand risk and to excessive renegotiations that will end up jeopardizing public interest.

5.9.2 Partial Amortization of the Investment

Most PPP contracts assume a full amortization of the investment during the contract duration. This is the main reason for having contracts of 30 or 40 years. Nevertheless, even considering the duration of these contracts, it is hard to justify an amortization of 30 years for a bridge, which has an average lifespan of 80, 90 or even more than 100 years.

If one considers limiting the percentage of amortization in a certain contract, the duration of the contract can be lower, thus decreasing the exposure to long term uncertainty and consequently decreasing the probability of renegotiation (Viegas 2010). This is also positive because of the competitive and contestable environment created (through rebidding).

5.9.3 Vertical Unbundling

Vertical unbundling consists in separating the contracts for the infrastructure and the operation. Naturally, this only makes sense in large projects. Otherwise, the transaction costs involved would not be justified. Moreover, this unbundling only

makes sense in projects where the operation is complex, thus representing an important risk. In highways, it does not make sense to unbundle the maintenance or the toll collection. Conversely, in hospitals or rail services, it may provide an important advantage by splitting up the risk and defining specific contracts for entirely different components of the project. For the construction, the bidders will essentially be construction firms, while the operation will attract specialized operators.

5.9.4 Public Tender for All Public Works

Many renegotiations take place because of the need of new public works that were not foreseen. In these cases, to avoid renegotiation, and particularly to avoid a situation where the government only has one price and one proposal, these types of public works should be awarded through a competitive tender. By doing this, the public sector ensures that the incumbent will not try to capture excessive rents from new public works.

5.9.5 Fair Compensation for Contract Termination

If the compensations for contract termination established in the contract are extremely generous for the private sector, the bargaining power of the public sector within the renegotiation process is very limited. The private sector knows that it would be very difficult for the government to terminate the contract and pay the compensation. Conversely, if the compensations are very low, they could also induce politically biased attitudes and leave the private sector exposed to changes. In fact, what would happen is that the private sector would either require a very high premium risk or would not accept engagement in the project.

5.9.6 Allow for Greater Flexibility Within Contracts

Most PPPs are based on rigid contracts, which are supported on the assumption that the future can be forecasted. This is a flawed assumption. Forecasts fail, leading to renegotiations. If contracts were based on the premise of a more flexible managerial approach and had better ability to address uncertainty, the probability of renegotiation would decrease. This issue was developed in detail in Chapter 3.

5.9.7 Effective Contract Management

Effective contract management has a twofold purpose: (1) to ensure that the contract is being correctly fulfilled by the concessionaire (applying bonus or penalties when appropriate) and, particularly, that risk is properly managed and

(2) to guarantee that the public sector retains a proper level of information, which will support the negotiation when the contract has to be revised. As mentioned earlier, renegotiations' outcomes are often jeopardized because of the problem of information asymmetry, which can only be mitigated through effective contract management. Therefore, it is essential to develop an adequate management structure that will transfer to the public sector the critical information regarding the project, a deep understanding of the business determinants and both the successes and failures of the project. This information allows anticipating potential renegotiations and preparing the supporting material for a bilateral negotiation, searching for the solutions that will protect public interest.

5.10 Governance Model for Renegotiation

The renegotiation process is highly complex. Each stakeholder has distinct motivations and pressures, and the object of the dispute might be a multi-million dollar investment. Furthermore, the renegotiation process often happens within political disputes, which adds more controversy to the process and decreases the fundamental technical view of the process.

The rules for managing the renegotiation process have to account for the specific legal and regulatory framework of each country. Nevertheless, one can discuss a "best case scenario" that represents a theoretical model that would allow for a more structured process, thus decreasing the likelihood of negative outcomes for the public sector.

The first step in the entire renegotiation process is the claim by one of the parties that the contract needs revision. To do so, it is necessary that an event triggers the renegotiation. This event might be an unforeseen disruption or, more commonly, situations where the demand is below the forecast or the investment plan changed, among many other events already discussed in this chapter. Next, the other party should analyze the claim and decide what assumptions are correct and whether the process of renegotiation should begin. This is an interactive process, meaning that there should exist a common understanding of the assumptions of the original contract that need to be revised. If this understanding is not reached, the process ahead becomes much more complex. It should start again (but the result can be the same) or the parties might appeal to the arbitration or look to other mediation means or litigation. To ensure that this understanding is reached, the parties should establish a *memorandum* of understanding of the assumptions being revised in the renegotiation process. This can be considered the first stage of the renegotiation process, or "pre-renegotiation process".

Afterwards, the core of the renegotiation process begins. To be more effective and efficient, a task force should be created with the same number of members from both parties to do a technical, legal and financial analysis. First, it is necessary to analyze from a technical perspective how the changes will affect the infrastructure and/or service (e.g., in cases where there are changes in the investment plan). It is also required to verify whether the changes in the original contract go against

specific regulations. If so, the renegotiation team should find feasible legal solutions. The OBC is an integral part of the contract. Therefore, a critical step in the renegotiation process is to update the OBC. This is a particularly sensitive matter. In cases where there is no prior understating about the assumptions that should be changed in the OBC, each party, at this stage, may try to change whatever is more favorable to them. In contrast, if that understanding exists, only the assumptions of the *memorandum* should be changed in the updating process. This makes the process more effective, efficient and transparent. Note that changes should be strictly based on the effect in the OBC of the event that caused renegotiation and for which the risk matrix should be kept; they should not be used for the concessionaire to recover losses of the costs associated with the risks it retains.

At this stage, the renegotiation reaches its critical point. Each party needs to argue its perspective and try to extract the most benefit out of the process. This is a demanding period, and it will most likely require several interactions until a common agreement on the renegotiation outcome is reached. When this happens, it can be necessary to ask for the approval of the regulator, who is supposed to work as a referee. If the regulator does not approve, the reasons for the denial will have to be included in the new iteration of the renegotiation process. The process is concluded when both parties reach an agreement and the regulator approves the new contract terms.

Along with the different stages of the process, it is important to disclose some information and allow for public participation. Essentially, there are three documents stating when this should happen. The first is the *memorandum* of the understanding of the assumptions for the renegotiation. If the initial contract is no longer valid, it is important for the public to know why and what has changed that will require a new contractual framework or, at least, a change in the prices they pay for the services or in the public subsidies given to the concessionaire. The second is the drafted proposal of the changed contract including the reviewed OBC. Before the changed contract is signed, it is important to know what was has been changed, and finally, the third, is the final and approved changed contract and the corresponding OBC. Figure 5.2 illustrates the entire process of renegotiation.

5.11 Main Findings

Renegotiations are frequently regarded as a contract failure. Indeed, renegotiations are required when the contract is not able to address certain events or circumstances. However, adjusting the contract to these new events does not necessarily mean jeopardizing public interest. This only happens if the process allows for opportunistic behaviors.

The fact is that renegotiations are often a strong argument for PPP critics, supporting their skepticism in the inability of governments to defend their interests in the processes. The concern that renegotiations are a major problem in regulation by contracts is supported by the case studies analyzed. The renegotiation rate in Latin American and Portuguese infrastructure concessions has been high,

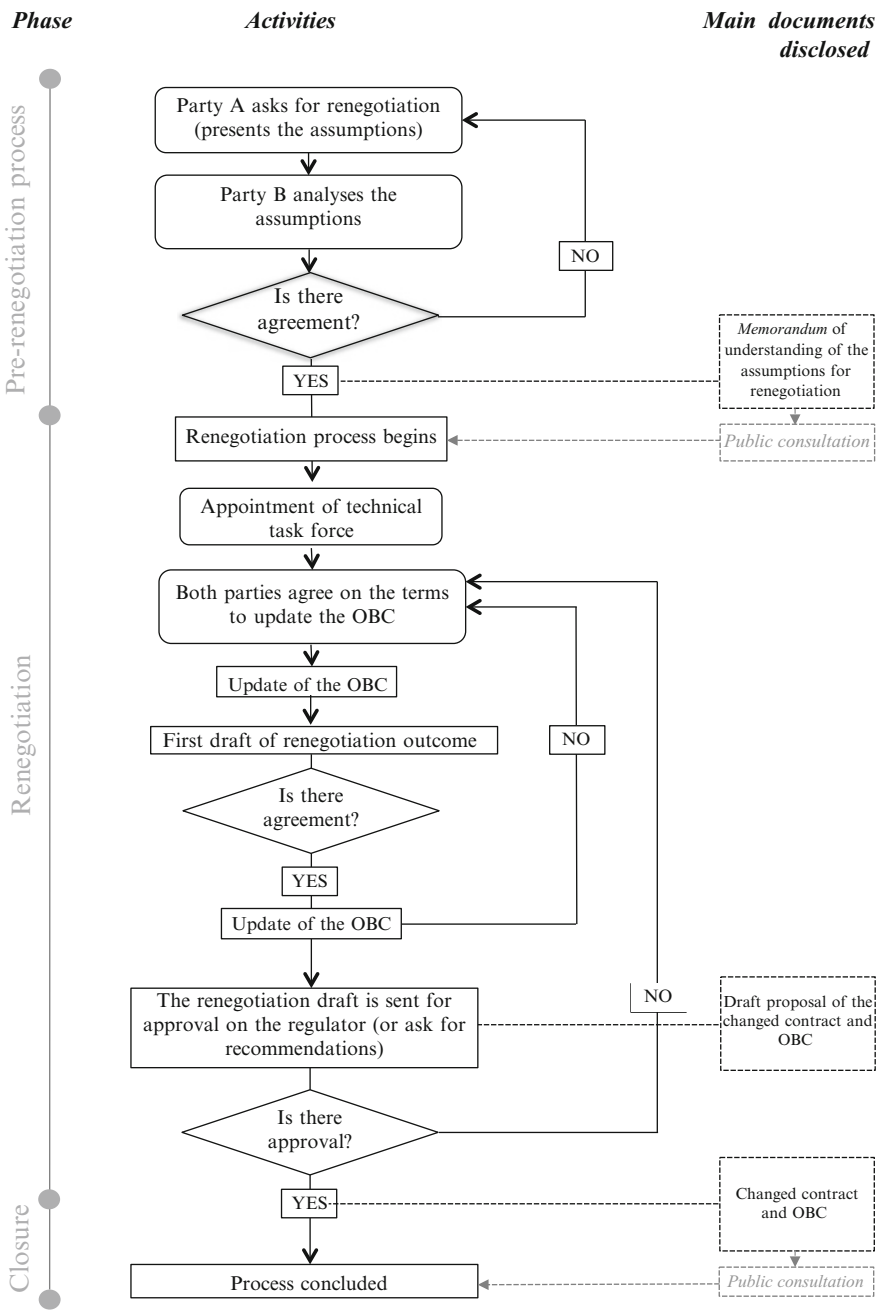

Fig. 5.2 Scheme of the renegotiation process

particularly in transportation and water, where it reached a 100 % rate. Although some of the contracts have been recently signed, the evidence offers substantial support to concession critics. The need to renegotiate in the long term to readjust contracts to evolving circumstances is unquestionable, but the fact that most renegotiations tend to happen in the first couple of years suggests that time uncertainty is not the main driver.

The econometric analysis shows that the probability of renegotiating increases with the size of the concession as well as with the lack of regulation when contracts are signed. The correlation between the type of award and the *ex-post* renegotiation also supports both the "winners' curse" and the strategic underbidding theorem. The pressure for achieving efficiency gains through competition seems to foster aggressive bidding and few years later, results in additional compensation for the concessionaire.

Renegotiations can jeopardize and erode the advantages of competitive bidding, questioning the entire concept of PPP use. Nevertheless, no matter what improvements are made in mathematical forecasting, there will always be a high degree of uncertainty in forecasting for the long term. The question of how to manage renegotiations rather than avoid them to decrease the risk of opportunistic use should be answered. Renegotiations happen because of two different effects. One effect is the problem of contract asymmetry and opportunistic behavior by governments and concessionaires (as mentioned in the earlier section).

The other effect is the problem of extreme unforeseeable events, for which none of the parties has privileged information, for example, natural disasters, wars, etc. These events are usually referred to as *force majeure* or 'acts of god'. In these types of events, the agents have symmetric information, or, more accurately, no information. The effort to increase contract completeness by foreseeing all possible contingencies can incur unbearable transaction costs.

Acknowledging that renegotiations will likely happen can help improve contract design. The rationale for the EFR model is that the concessionaire and grantor agree upon the rules to follow in case of renegotiation and on what type of events can trigger the renegotiation (and the KPIs to measure them). Uncertainty is not foreseeable but could be manageable. Despite the benefits of the EFR model, there can be problems when it is not only applied to the event that triggered the renegotiation.

The process should only begin if one of the events written in the contract produces chances in the KPIs above the pre-defined thresholds, for example, a unilateral contractual change made by the government that increases the costs, decreasing the IRR above the margin. After the contract is "open", if the concessionaire is able to "bring" other changes to the OBC in the negotiation, e.g., operational and/or financial costs, not directly related to the event that triggered the renegotiation, the process is biased and can induce strategic behavior.

As mentioned earlier, the possibility of an *ex-post* renegotiation where the concessionaire can recover losses has a perverse incentive to bid aggressively "for the market". Therefore, there are two drivers for the opportunistic use of EFR: first, establishing low thresholds to "open the contract" and, second, bringing

to the process claims that should not belong to the renegotiation perimeter and changing the risk matrix. Regarding the first reason, most of concessions analyzed, particularly in roads and water and wastewater systems, have proven to be inadequate, with excessively low triggers. These sectors have been prone to opportunistic behavior by concessionaires.

Very low thresholds will allow an "open contract" very easily and can be used strategically by concessionaires to initiate the process. If the concessionaire is allowed to bring to the process other claims besides the event that triggered the renegotiation, then success is jeopardized. In addition to providing incentives for aggressive bidding, this outcome transforms the contract into a "cost-plus" scheme, and if the model resembles a cost-plus scheme more than the award criteria, it should take into account the IRR required by each bid.

In fact, a concessionaire can underestimate the construction costs, or operating costs, lowering the final price of its bid while keeping a high IRR. Once the contract is open (and the data show that is not a question of "if" but rather "when"), the contractual mechanisms that ensure that the re-equilibrium of the IRR can allow the concessionaire to recover the initial losses. The grantor will be paying a "premium" (IRR) that may not be the lowest because the IRR is not often evaluated in the awarding process.

How can this problem be avoided? Regarding the design of triggers, it seems clear that larger thresholds should be applied to accommodate small changes, which have virtually no impact on the concessionaire's return. Decreasing the risk of "opening" the contract will decrease the changes of harming public interest during the renegotiation. Simultaneously, it is necessary to ensure that the EFR model is only applied to the events that the renegotiation originated from. This requires a third agent, regulatory agency or a court (e.g., Court of Auditors, to supervise the process). Given the specificity of the sectors and the level of technical detail in some renegotiations, sector specific regulation, through a contract manager with a deep understanding about the contract itself, should be the first solution.

Conclusions

6

6.1 Final Remarks

Large-scale infrastructure has some particular features that require special attention from project managers. It has a public interest status, strong externalities, characteristics of natural monopolies and a high vulnerability to uncertainty. This vulnerability arises from the large sunk investments required and from the difficulty in accurately forecasting the demand/consumption in the long run. This raises several challenges regarding the involvement of the private sector in the provision and management of infrastructure and also helps justify why the full privatization process has raised suspicion for most countries' governments.

With the ability to maintain the benefits of private management while maintaining some degree of control by public authorities, PPP appeared as an obvious model. In Europe, until recently, the public expenditure with this model was not accounted for in the public deficit calculation, which resulted, in some countries, in an "overuse" of the model in projects that should not be developed, with negative consequences for the public budget.

The recent economic and financial crisis impacted the PPP markets, although differently, across the world. In Europe, it is clear that the levels of PPP development decreased, at least those related to large construction projects. The fact is that although the construction activities have decreased, there are several PPP projects currently under development and/or consideration not for building systems but rather for managing them. This also has to do with the fact that the levels of infrastructure development in Europe are high compared with other countries. Around the world, as mentioned earlier in South America, Africa and Asia, the use of the model is growing, but the drivers are not the same as those that motivated the use of PPP arrangements in Europe. For most of these countries, there is no motivation for bypassing the public budgets, and many do not even have the need to access private capital (e.g., Brazil). The main motivation lies in the need to involve the adequate know-how of managing the infrastructure and/or services, not even considering alternative procurement models (there is no PSC calculation). The PPP

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model will be of great use for governments around the world, but the geographical focus is changing, as in most economic activities.

Next, some key conclusions for each chapter will be presented, along with some future developments for this promising research area.

6.2 Public Sector Comparator

The calculation of the PSC is a controversial step in PPP development and implementation. In Chap. 2, several pitfalls and flaws were identified, but it is important to consider that the PSC is "just" a tool, and therefore, it should be used to support the decision making process and should not be taken as irrefutable proof. Irrespective of the different levels of sophistication for calculating the PSC, there is always a great deal of uncertainty surrounding the final result.

To calculate the PSC, the best practices involve disaggregating the calculation into several components: the raw PSC, risks (transferred, retained and shared) and the competitive neutrality effect. Calculating each one of these components allows for a better understanding of the cost structure and, particularly, of the risks involved and their consequences. In addition to the PSC structure, there is also another critical issue: the choice of the discount rate. Entirely different values are used for the discount rate and different methodologies determining the value to be used (fixed administratively or calculated through the WACC). Nevertheless, small deviations in this rate can have an enormous impact on the final result, leading to biased comparisons. The same levels of uncertainty can be found in cost estimation. How should these levels of uncertainty be addressed? The methodology suggested in this book is that the implicit uncertainty surrounding the PSC calculation should be made explicit in the result. This means that instead of a single number with a probability of occurrence close to zero, decision makers should be looking at probabilistic distributions and levels of confidence. This can be made by using more simple methods, e.g., a Monte Carlo simulation, or more complex statistical methods, e.g., BN. One may argue that this will add complexity to the process, which indeed will happen, but it will also increase the transparency of the calculation by making the errors assumed in each input explicit.

In addition to these issues related to the calculation, there are other important procedural questions regarding the use of the PSC. The theoretical rationale for calculating the PSC is to select the best procurement model: PPP or traditional procurement. In reality, for several different reasons, some projects are already selected for PPP arrangements. In these cases, does it still make sense to calculate the PSC? The answer is yes. By calculating the PSC, the public sector will have a better sense of the cost structure and the main risks, and it can also use the calculation for simulating alternative risk-sharing arrangements, which can be extremely useful in the context of a negotiation.

Another important issue is the disclosure (or not) of the PSC to bidders. There are advantages and disadvantages to both options. By disclosing the PSC, the bidders will improve their proposals at least to the level defined by the PSC. If

the PSC is calculated assuming significant efficiency gains, this might place some pressure on the bidders. The disclosure of the PSC also validates the calculation, which is not immune to errors or dubious assumptions. Nevertheless, if bidders know the PSC, they may have no incentive to go beyond it, and this might limit the potential for delivering solutions with a higher VfM. This is particularly important if the number of bidders is very low and does not ensure a real competition.

The PSC should be calculated at a very early stage because it will allow the public sector to be aware of the lifecycle costs and revenues, and particularly, it will provide a tool to simulate alternative risk-sharing agreements that might be extremely useful when deciding which contractual arrangement to use.

Finally, it is important to decide the "legal status" of the PSC. Should it be merely informative or should it have a mandatory status? The answer to this question heavily depends on each country and each particular sector, but it is important to consider that the PSC will only be given relevance under a proper status.

6.3 Contractual Flexibility

The principle behind contractual flexibility is to give the private sector the managerial flexibility to address future uncertainty. In Chap. 3, several types of flexibility were presented, located in different levels and with different configurations, but there is no exhaustive list for flexible options because most of the options are intrinsically related to the project characteristics. Some projects are more prone to flexibility than others, as mentioned earlier.

Nevertheless, most infrastructure PPP projects are interesting examples for considering a more flexible approach in contract design because of the high levels of investment as well as the uncertainty surrounding the project. In fact, it was because of these features and because of the need to decrease the uncertainty for the private sector that current contracts are rigid.

Making contracts more rigid has a negative effect because it decreases the levels of risk transfer, minimizing the incentives for an efficient and active management. The rationale behind the contractual flexibility is to allow the private sector to manage, within some boundaries, the project to cope with unveiling circumstances and events.

The case study analyzed in this book illustrates how it is possible to increase a PPP project NPV through a flexible contractual design. However, as mentioned, this cannot be extrapolated for all flexible options in any project. Each case needs to be carefully assessed because in some circumstances, the options value can be negative. Assuming, as demonstrated, that the flexible contract does increase the project NPV, how should the economic surplus be used? According to the model developed in this book, this economic surplus is captured by the concessionaire. However, in a real case study, some claw-back mechanisms should be considered to allow the public sector to benefit from these gains. In theory, the public sector has already benefited from the economic surplus of flexibility in the tender process. If

potential bidders give a positive value to the flexible option, it is likely that this will be reflected in their proposal. The existence of claw-back mechanisms will decrease their willingness-to-pay in the tender.

The value of flexibility increases over time, so, to extract the full benefit of these contracts, it is necessary to have long contracts. Only with a long term commitment is it possible to change and adapt the infrastructure and/or service to new conditions. By having longer contracts, the market will be more time closed to competition. There is a trade-off between the flexibility and the contract duration that needs to be taken into account.

6.4 Contract Management

Contract management is frequently considered as the poor relative of the PPP project life-cycle. Most stakeholders and, in particular, politicians are focused on the construction stage and, to a less extent, on the planning and public tender stages. This is wrong in principle because it is in the operation stage that the infrastructure or the public service provides the function for which it was developed and interacts with users or customers. Appropriate contract management is also a key aspect for the PPP project success not only to achieve and assure that the objectives are fulfilled but also to mitigate and even avoid PPP renegotiation, which is often observed as the major failure of the PPP contract.

Contract management is a multi-disciplinary activity, covering technical, financial and legal aspects that require costly resources and preparation before signing the PPP contract. The existence of governance structures that allow the management of several infrastructure contracts has revealed itself as very effective option. Examples of contract management in several states of Australia and Canada might be followed by other countries.

The contract management activity involves the operational management, the relationship management and the administrative management domains, whose balance is decisive for successful PPP projects. These domains of contract management encompass a set of activities and aspects that were grouped into key elements. Some of them are instrumental and mainly concern the internal workings of contract management, including the information collection and analysis, the contract administration, the contract governance and its continuous review. Its incorrect handling by the public partner will jeopardize the development of key activities of contract management and, therefore, the objectives of the PPP project. The remaining domains correspond to the main activities to be developed by contract management, comprising performance monitoring and reporting, relationship management and conflict, problem resolution and information, knowledge management, event management and planning of contingencies. If these activities are neither planned nor considered in the project development in a suitable way, the objectives for which they have been designed will be put in danger. Chapter 4 provided an insight about these key contract management activities, and it also discusses the major pitfalls of contract management.

6.5 Renegotiation

Although, in some sectors, the number of renegotiations per contract can be reduced, renegotiation is extremely difficult to avoid in PPP projects. Most of the experiences with renegotiation processes have been far from ideal. When a renegotiation is required, it is necessary to have in place rules and guidelines to improve the performance of the process and avoid distorted results.

Either as a result of contract asymmetry and opportunistic behavior by both agents, or because of unforeseeable events, both the public and private sectors need to acknowledge that there is a high probability that the contract will need changes in the future. Therefore, it may be useful and important to establish a priori some guidelines to manage the process. The EFR has some advantages to decrease the discretionary management of the renegotiation process and, particularly, its outcomes by defining both the triggers and the rules for restoring the economic and financial equilibrium.

However, as discussed, it is important to define reasonable intervals for triggers. Otherwise, the solution might become a problem by initiating the renegotiation process for any small change. It is also crucial to ensure that the renegotiation process only accounts for the event that initiated the renegotiation. If one of the agents brings other claims not related to the event that initiated the renegotiation, the merit of the process is jeopardized. Moreover, it provides an incentive for future opportunistic behavior, forcing the renegotiation to open and then trying to recover from losses.

This book presented several guidelines regarding contract structure and contract design to decrease the probability of renegotiation, with a particular emphasis on contractual flexibility. Notwithstanding the importance of considering alternative contractual arrangements, when renegotiation is inevitable, it is important to have pre-established procedures to increase the transparency and the efficiency of the process, as presented in Chap. 5. If renegotiations cannot be avoided at least they can be managed.

6.6 Further Developments in PPP Research

6.6.1 Governance

Concerning governance, several interesting and unanswered questions have emerged during the course of this research, some related to large scale infrastructure projects in general, others to PPP contracts in particular, and many to the main areas focused on this book. Many questions were raised in the several chapters. Although PPP arrangements have been in place for quite a while, an analysis of the governance of these projects is still missing. Each country adopts its own rules and management bodies, but there are still relevant gaps in questions. What are the existing models for PPP governance? What have been the major advantages and pitfalls? How can we improve the process?

6.6.2 Financing

This issue of infrastructure financing has never been so discussed as recently, mostly because of the worldwide financial crisis. Bonds, bank loans, equity, and all capital cost have escalated over the last years. It is clear that the financing risk is tremendous, and it should most likely be isolated and treated separately. This might be executed, for example, by separating the financing from the construction and management of the infrastructure, changing the way consortiums are organized. This issue is a promising field of research.

6.6.3 PPPs in Developing Countries

Recently, growing attention has been paid to PPP projects in developing countries. With tremendous infrastructure gaps, most African and some Asian countries are considering and developing the first projects. Nevertheless, much of what it is known about PPP arrangements needs to be adapted to the economic and social conditions in these countries, for example, concerning financing or contract management, or ensuring enough competition for the project. This concerns not only developing countries but also some large economies such as Brazil, India or China. Adapting the experience of developed countries to these emerging economies is an issue that needs to be studied.

6.6.4 PSC

Several paths can be followed to improve the robustness of the PSC calculation of the PSC. What should be performed when there are no historical data or when the data are not to be trusted? Is the PSC really an alternative? The question arises because, in many cases, the alternative of developing the projects under public management is not a "true" alternative. Using Bayesian models, how to accommodate experts judgments, and how to determine the respective weights?

6.6.5 Renegotiations

To fully understand the phenomenon of renegotiations, other complementary analyses should be performed, even though the amount of information that is required is not presently available. As an example, one can note the question of whether the renegotiation of the project due to changes in the concession scope improves the service provided to users and, if so, how effective is that improvement from a social welfare perspective. The renegotiation should only go forward if the net benefit is higher than the cost of renegotiating. To our knowledge, this CBA has never been performed and should be further developed to ensure that public interest is protected.

6.6.6 Flexibility

The possibility of flexible contracts in PPP development is one of the most relevant paths in the area, and several research questions can be raised. From the work developed in this book, one of those questions is the issue of the trade-off between the value of the flexibility versus the decrease in the competition by having longer contracts. Flexibility requires commitment in the medium to long run, while to have competitive biddings more often, it is necessary to reduce the contract length. This balance certainly deserves some attention by infrastructure researchers and practitioners.

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