CONTRIBUTIONS
TO MANAGEMENT SCIENCE

Hady Farag

Collaborative Value Creation

An Empirical Analysis of the European Biotechnology Industry

Physica-Verlag
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Contributions to Management Science

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Foreword

Collaboration plays an important role in the early development of companies. Among others, they provide opportunities to combine complementary resources, develop additional competencies, and generate valuable signals for investors. They are particularly important for biotechnology firms, whose resource base often is not sufficient to realize the market potential of their R&D findings. Strategic alliances thus are an integral part of the business model of most biotechnology companies, but their economic relevance is not yet fully understood, since research has thus far neglected most industry-specific drivers of alliance value.

Based on an event study, Hady Farag analyzes the capital-market reaction to alliance-related news announcements and assesses their complex effects on company value. In this regard, the present work represents the first comprehensive study of European biotechnology alliances. In addition to this unique database, the research approach and techniques in sample selection, econometric and cross-sectional analyses are state-of-the-art.

The author develops and empirically tests an integrative dynamic model of collaborative value drivers. These reflect the specific characteristics of biotechnology firms and biotechnology alliances. Moreover, the work extends to so far entirely unresearched dynamic aspects of alliances, such as the value of contractual flexibilities, the impact of environmental uncertainty, and the evolution of alliances over time. Overall, Hady Farag's work underscores the need to consider pluralistic influences on the value of collaborative ventures.

The present reserach significantly expands our understanding of collaborative value creation and derives implications for both academia and real-world practice. Its findings are of particular relevance now that capital market conditions have become much less favorable than during the initial biotechnology bonanza, but have improved vis-à-vis the recent downturn. Given its broad scope and consistently high level of quality, I am sure that this publication will be well received by fellow researchers and practitioners alike.

Oestrich-Winkel/Brussels, July 2008 Prof. Ulrich Hommel, Ph.D.

Preface

Various individuals have supported the successful completion of my doctoral research, each and every one in their own ways. I owe my greatest thanks to all of them.

First and foremost, I am grateful to Prof. Ulrich Hommel, Ph.D., with whom I had the priviledge of working in a variety of functions at the European Business School. His intellectual curiosity, complete trust and support were greatly motivating and I proudly refer to him as a friend. Also, I would like to thank Prof. Corinne Faure, Ph.D., for serving as my thesis referee and for sharing her insights into empirical research. I greatly appreciated the discussions with my friends and colleagues at the European Business School and the sense of belonging they provided. Among others, they include, Gudrun Fehler, Dr. Christof Engelskirchen, Dr. Mischa Ritter, and Dr. Marc Schuhmacher.

The German National Merit Foundation financially supported my doctoral research and provided opportunities for learning about topics unrelated to my own business background. My work also benefited from discussions at various academic conferences and analyst meetings.

A number of close friends have always been a source of great strength to me. Even if I cannot individually name them here, I deeply appreciate them and shared meaningful moments with each of them: Friends from way back when (such as Wencke Wassermann), peers from my student days (such as Katrin Esser), friends joining my long days at libraries and evenings out in Frankfurt (such as Stefan Hirche), and most recently my colleagues at The Boston Consulting Group (such as Dr. Jens Kengelbach).

The one person, whom I am most indepted to is my mother, Edeltraut Farag. Together with Waldemar and Axel Kurth, she provides a family environment I cherish and gladly return to time and again. Without her faith in me and her unwaivering support, this success (and all others) would not have been possible. I therefore dedicate this book to her as well as to the memory of my father, Ahmed Farag, who contributed greatly to the person I am today. Thank you!

Frankfurt/Hannover, October 2008 Hady Farag

Table of Contents

List of Abbreviations

AAR	Average AR
AC	Absorptive Capacity
ADF	Augmented Dickey-Fuller (test)
ADME	Absorption Distribution Metabolism Excretion
ANL	Average Number of Listings
APT	Arbitrage Pricing Theory
AR	Abnormal Returns
ARMA	Autoregression, moving-average
B.C.	Before Christ
B2B	Business-to-Business
Big Pharma	Major Pharmaceutical (Firms)
BIO	Biotechnology Industry Organization
BLUE	Best Linear Unbiased Estimator(s)
BV	Book Value
BW	Brown-Warner (Test)
CAAR	Cumulative Average AR
CAPM	Capital Asset Pricing Model
CAR	Cumulative AR
cf.	Confer
Corr	Corrado (Test)
CRSP	Center for Research in Security Prices
CS	Cross-sectionally standardized (Test)
DBF(s)	Dedicated Biotechnology Firm(s)
DCF	Discounted Cash Flows
DGAP	Deutsche Gesellschaft für Ad-hoc Publizität
DNA	Deoxyribonucleic Acid
DVFA	Deutsche Vereinigung für Finanzanalyse und Assetmanagement
DW	Dodd-Warner (Test)
d Stat	Durbin-Watson d statistic
e.g.	Exemplii gratia
EBIT	Earnings before Interest and Taxes
eCommerce	Electronic Commerce
EJVs	Equity Joint Ventures
EMH	Efficient Market Hypothesis
et al.	et alii
FCF(s)	Free Cash Flow(s)
FDA	Food and Drug Administration
FE	Fixed Effects
(F)GLS	(Feasible) Generalized Least Squares
FN	Footnote
(G)ARCH	(Generalized) Autoregressive Conditional Heteroskedasticity
GLSE	Generalized Least Squares
IJV(s)	International Joint Ventures(s)
i.e.	Id est

IO	Industrial Organization
IPO(s)	Initial Public Offering(s)
IT	Information Technology
JV(s)	Joint Venture(s)
KGaA	Komanditgesellschaft auf Aktien
LM	Lagrange Multiplier (test)
Log	Logarithm
LSDV	Least Squares Dummy Variable
M&A	Mergers and Acquisitions
Max.	Maximum
ANOVA	Analysis of Variance
MLE	Maximum Likelihood Estimation
MV	Market Value
n.s.	Not significant
N/A	Not applicable
NBE	New Biological Entity
NCBI	North Carolina Biotechnology Information
NCE	New Chemical Entity
NIE	New Institutional Economics
No	Number
NPD	New Product Development
NPV	Net Present Value
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
p.	Page
PhRMA	Pharmaceutical Research and Manufacturers of America
R&D	Research and Development
RBV	Resource-based View
RE	Random Effects
ReCap	Recombinant Capital
S&P 500	Standard and Poor's 500 Index
SA	Strategic Alliance
SAAR	Standardized Average Abnormal Returns
SAR	Standardized Abnormal Returns
SCAAR	Standardized Cumulative Average Abnormal Returns
SCP	Structure Conduct Performance
SD	Standard Deviation
SESTA	Swiss Stock Exchange Act
SIC	Standard Industry Classification
sign	Significant
SPO(s)	Secondary Public Offering(s)
TCE	Transaction Cost Economics
U.K.	United Kingdom
U.S.	United States
UKLA	UK Listing Authority
VC	Venture Capital
VIF(s)	Variance-Inflation Factor(s)
Vol.	Volume
vs.	Versus
WIPO	World Intellectual Property Organization
WpHG	German Security Trading Law (Wertpapierhandelsgesetz)

List of Variables

Dependent Variables (Abnormal Return Measures)

	Daily abnormal returns:
arMM	• Standard market model using Stoxx 600 index
ar2F	• Two-factor model (country-specific/Stoxx Biotech)
arBT	• Standard market model using intra-sample index
arBTi	• Index-correction model using intra-sample index
	Cumulative abnormal returns (2-day window):
carMM2	• Standard market model using Stoxx 600 index
car2F2	• Two-factor model (country-specific/Stoxx Biotech)
carBT2	• Standard market model using intra-sample index
carBTi2	• Index-correction model using intra-sample index
	Cumulative abnormal returns (3-day window):
carMM3	• Standard market model using Stoxx 600 index
car2F3	• Two-factor model (country-specific/Stoxx Biotech)
carBT3	• Standard market model using intra-sample index
carBTi3	• Index-correction model using intra-sample index
	Cumulative abnormal returns (4-day window):
carMM4	• Standard market model using Stoxx 600 index
car2F4	• Two-factor model (country-specific/Stoxx Biotech)
carBT4	• Standard market model using intra-sample index
carBTi4	• Index-correction model using intra-sample index

Environmental Variables

mktactivity	Number of alliances/M&A transactions (12-month window)
mktretsx	Return on Stoxx 600 index (200-day window)
mktretsb	Return on Stoxx Biotech index (200-day window)
mktretbt	Return on intra-sample index (200-day window)
mktvolsx	Volatility of Stoxx 600 index (200-day window)
mktvolsb	Volatility of Stoxx Biotech index (200-day window)
mktvolbt	Volatility of intra-sample index (200-day window)
mktretbtout	Interaction of intra-sample index return (mktretbt) and volatility (mktvolbt)
mktvolbtout	Interaction of intra-sample index volatility (mktvolbt) and outbound alliance direction (d_outbound)

Focal Firm Variables

focalstaff	Number of Employees (prior year)
focalstaff2	Squared number of employees (prior year)
focalstafflog	Logarithmic number of employees (prior year)
age	Firm age (number of years since foundation)
agep	Firm age (number of months since IPO)
focalsales	Sales in k€ (prior year)
focalassets	Assets in k€ (prior year)
focalmve	Market value in k€ (end of prior year)
focalp5	Number of patents (5-year window)
focalp3	Number of patents (3-year window including next two years)
experience	Number of prior alliances (excluding focal alliance)
experience2	Squared number or prior alliances (excluding focal alliance)
focalebit	EBIT in k€ (prior year)
focalncf	Net Cash-Flow in k€ (prior year)
focalocf	Operating Cash-Flow in k€ (prior year)
focalbvd	Book Value of Debt in k€ (prior year)
focalq	Tobin’s q (prior year)
agestaff	Interaction of focal-firm age (agep) and size (focalstaff)
priorp5	Interaction variable of
mktretvolbt	Interaction Variable of market return and market volatility
benelux	Dummy variable for Benelux firm origin
scand	Dummy variable for Scandinavian firm origin
germany	Dummy variable for German firm origin
fritch	Dummy variable for French, Italian or French firm origin
y2-7	Dummy variable for years 1997 (y2) to 2003) (y7)

Partner Firm Variables

pstatus	Dummy for publicly listed partner
ppstatus	Dummy for privately held partner
pp	Number of patents (5-year window)
ppp	Number of parent-firm patents (5-year window)
pppp	Number of partner and parent-firm patents (5-year window)
ptrans	Number of prior alliances
pptrans	Number of prior parent-firm alliances
ppptrans	Combined number of prior partner and parent-firm alliances
ptype_ph	Dummy for pharmaceutical firm
ptype_bt	Dummy for biotechnology firm
ptype_res	Dummy for research institution (including universities)
ptype_oth	Dummy for other partner-firm type
pregion_us	Dummy for North American partner origin
pregion_eu	Dummy for European partner origin
pregion_j	Dummy for Japanese partner origin
pregion_main	Dummy for main market origin (North American or European)

Transaction Context Variables

i_cns	Dummy for central nervous system disorder as targeted medical indication
i_cancer	Dummy for cancer as targeted medical indication
i_cadiovas	Dummy for cardiovascular disorder as targeted medical indication
i_infectious	Dummy for infectious disease as targeted medical indication
i_inflammation	Dummy for inflammation as targeted medical indication
i_metabolic	Dummy for metabolic disorder as targeted medical indication
i_other	Dummy for other disorder as targeted medical indication
i_respiratory	Dummy for respiratory disorder as targeted medical indication
i_various	Dummy for multiple targeted medical indications
f_rnd	Dummy for R&D as function focus of collaboration
f_comm	Dummy for commercialization as function focus of collaboration
f_manuf	Dummy for manufacturing as function focus of collaboration
scope2	Dummy for collaboration including further functional focus (in addition to main one)
exploitation	Dummy for exploitation as stage of collaboration
exploration	Dummy for exploration as stage of collaboration
m_drug	Dummy for drug discovery as business model pursued in collaboration
m_technology	Dummy for platform technologies as business model pursued in collaboration
m_service	Dummy for service delivery as business model pursued in collaboration
m_hybrid	Dummy for hybrid business model pursued in collaboration
m_other	Dummy for other business model pursued in collaboration
d_outbound	Dummy for outbound direction of resource transfer
d_inbound	Dummy for inbound direction of resource transfer
d_joint/cross	Dummy for joint resource development or reciprocal resource exchange
rndexploit	Interaction variable of R&D focus of collaboration (f_rnd) and exploitation stage (exploitation)
drugexploit	Interaction variable of drug discovery business model (m_drug) and exploitation stage (exploitation)
drugout	Interaction variable of drug discovery business model (m_drug) and outbound direction of resource transfer (d_outbound)
drugrnd	Interaction variable of drug discovery business model (m_drug) and R&D focus of collaboration (f_rnd)
exploitout	Interaction variable of exploitation stage (exploitation) and outbound direction of resource transfer (d_outbound)
rndout	Interaction variable of R&D focus of collaboration (f_rnd) and outbound direction of resource transfer (d_outbound)

drugexploitout	Three-way interaction variable of drug discovery business model (m_drug), exploitation stage (exploitation), and outbound direction of resource transfer (d_outbound)
drugexploitrnd	Three-way interaction variable of drug discovery business model (m_drug), exploitation stage (exploitation), and R&D focus of collaboration (f_rnd)
drugoutrnd	Three-way interaction variable of drug discovery business model (m_drug), R&D focus of collaboration (f_rnd), and outbound direction of resource transfer (d_outbound)
rndexploitout	Three-way interaction variable of R&D focus of collaboration (f_rnd), exploitation stage (exploitation), and outbound direction of resource transfer (d_outbound)
exploit4way	Four-way interaction variable drug discovery business model (m_drug), R&D focus of collaboration (f_rnd), exploitation stage (exploitation), and outbound direction of resource transfer (d_outbound)
licshort	Dummy variable for license granted to partner firm
liclong	Dummy variable for license received from partner firm

Compensation Structure Variables

guarantlong	Dummy variable for guaranteed Payments to be received from partner firm
guarantshort	Dummy variable for guaranteed Payments to be made to partner firm
milestonelong	Dummy variable for milestone payments to be received from partner firm
milestoneshort	Dummy variable for milestone payments to be made to partner firm
royaltylong	Dummy variable for royalty payments to be received from partner firm
royaltyshort	Dummy variable for royalty payments to be made to partner firm
guarmilelong	Dummy variable for combination of guaranteed and milestone payments to be received from partner firm
guarmileshort	Dummy variable for combination of guaranteed and milestone payments to be made to partner firm
guarroyallong	Dummy variable for combination of guaranteed and royalty payments to be received from partner firm
guarroyalshort	Dummy variable for combination of guaranteed and royalty payments to be made to partner firm
mileroyallong	Dummy variable for combination of milestone and royalty payments to be received from partner firm
mileroyalshort	Dummy variable for combination of milestone and royalty payments to be made to partner firm

all3long	Dummy variable for combination of guaranteed, milestone and royalty payments to be received from partner firm
all3short	Dummy variable for combination of guaranteed, milestone and royalty payments to be made to partner firm
timelimit	Dummy variable for time-limited collaboration
time	Specified duration of collaboration (in months)

Other Transaction Structure Variables

prior	Dummy variable indicating prior collaborative relations between partners
allequity	Dummy variable indicating any kind of equity involvement (JV, equityshort, equitylong)
equityequity	Dummy variable indicating equity investments in/by partner (equityshort, equitylong)
equityshort	Dummy variable indicating equity investments by partner (in focal firm)
equitylong	Dummy variable indicating equity investments by focal firm (in partner firm)
jv	Dummy variable indicating joint venture formation
payin	Dummy variable indicating payments to be received from partner
payout	Dummy variable indicating payments to be made to partner
valuereport	Dummy variable indicating that transaction value is reported
value	Transaction value (excluding royalties, in m€)
valuepayin	Interaction variable of payment to be received from partner (payin) and transaction value (value)
optionality	Dummy variable indicating use of contractual flexibilities (focal and/or partner firms)
optionshort	Dummy variable indicating contractual flexibilities granted to partner firm
optionlong	Dummy variable indicating contractual flexibilities granted to focal partner firm
timelimitoption	Interaction variable of time-limited collaboration dummy (timelimit) and use of contractual flexibilities (optionality)
lambda	Lee-/Heckman-type correction variable reflecting likelihood of observation being included in/ excluded from sample

List of Symbols

Chapter 1

V_C	Value of collaboration
V_{DCF}	NPV of a set of (expected) future cash flows from collaborative venture
I_{Coop}	Investments required to assure cooperative behavior
V_{Flex}	Flexibility value of collaboration

Chapter 4

J	Number of alternative listings/classifications
K	Total number of firms included in any listing
k_{iUj}	Number of firms included in both focal listing i and listing j
k_i	Number of firms included in focal listing i
k_j	Number of firms included in listing j
$AR_{i, t}$	Abnormal return for given security i and day t
$R_{i, t}$	Observed return for given security i and day t
$E(R_{i, t})$	Expected return on security i for day t
α	Coefficient of regression model
β	Coefficient of regression model
$R_{m, t}$	Return on relevant market index for day t
s_i	Standard deviation of residuals in market model (or other return generating process)
$R_{m, t/\tau}$	Return on the market index for day t (event period) or τ (estimation period)
R_m	Mean Return on the Market Index during the estimation period
N	Number of observations
T	Number of days in the event period
L	Number of days in the estimation period
τ_1	First day of the event window
τ_2	Last day of the event window
$K_{i, t}$	Rank of the return on security i on day t within the combined estimation and event period
α_i	Fixed effects coefficient of panel regression model

u_i	Individual-specific error vector (i.e., variation in α for unit i)
Y	Dependent variable matrix (as in standard OLS)
X	Independent variable matrix (as in standard OLS)
B	Estimated coefficient vector (as in standard OLS)
$\Sigma\rho$	Estimated coefficient scalar on selection variables
Φ	Standard normal density function
Φ	Standard normal distribution function
$F(z, \gamma)$	Hazard function for observation i calculated based on covariates z and base hazard γ
H	Error term of self-selection correction model $[E(\eta \mid i=1, x, z)=0]$
$\log_0 (t)$	Base hazard in Cox conditional hazard model
$X\beta$	Matrix of explanatory variables and vector of corresponding coefficients
T	Survival time (i.e., time since last event)
λ (t,X)	Base hazard
t-1	Day preceding event announcement

Chapter 5

LL	Log likelihood
%	Percent
Df	Degrees of Freedom
F	F-statistic
R2	R-Squared statistic
Chi2	Chi-Squared statistic
P	p-value
	Correlation coefficient
sresAVG	Average studentized residuals
$	Dollar
€	Euro

Appendix

$C_{i \mid j}$	Relative Centrality Measure for Listing i with regard to Listing j
C_{iUj}	Centrality Measure for Intersection of Listings i and j
C_j	Centrality Measure for Listing j
N-1	Total Number of Constituents (Firms) in the Overall Network
C^A_i	Aggregate Centrality Measure for Listing i with regard to all other Listings
L	Total Number of Listings
$E_{i \mid j}$	Relative Efficiency Measure for Listing i with regard to Listing j
$a(p_i , p_k)$	Binary variable taking the value of 1 if point i in the network is linked to point k

$P_{i, t}$	Price of Security i on day t
$P_{i, t-1}$	Price of Security i on day t-1
$D_{i, t}$	Dividend paid on day t
$AAR_{N, t}$	Average abnormal return for N securities on day t
$CAR_{i, T}$	Cumulative abnormal return for security i over T days
$CAAR_{N, T}$	Cumulative average abnormal return for N securities over T days
$SAR_{i, t}$	Standardized abnormal return for security i on day t
$SD_{i, t}$	Standard deviation of abnormal returns
$SAAR_{N, t}$	Standardized average abnormal return for N securities on day t
$SCAR_{n, T}$	Standardized cumulative abnormal return for security i over T days
$SCAAR_{N, T}$	Standardized cumulative average abnormal return for N securities over T days
y_i (Y)	(Matrix of) observed realizations of dependent variables
α_i	Estimated intercept
β_i	(Vector of) estimated coefficients on independent variables
$x_{i, j}$ (X)	(Matrix of) observed realizations of independent variables
ε (ε)	Error term (vector)
x_t (X)	(Matrix of) observed realizations of independent variables
y_t (y)	(Vector of) observed realizations of dependent variables
x[bar]	Average value of independent variables
y[bar]	Average value of dependent variables
X'	Transposed matrix of observed independent variable realizations
w_{ij} [hat]	Estimated error term for variable i and observation j
u_i [hat]	Estimated error term for variable i

1 Introduction

"Completion of the Human Genome Project is not the end, or even the beginning of the end; it is but the end of the beginning."

Alan G. Walton, Oxford Bioscience Partners[1]

1.1 Motivation

Inter-firm collaboration has become an ever-present phenomenon in corporate practice. Since the 1980s, the frequency and diversity of corporate alliances have increased continuously. As (Ernst 2002) summarizes, "numbers have grown by more than 20 percent a year over the past two decades, while the way they are used has changed dramatically: The cross-border and technology agreements of the 1980s and early 1990s have given rise to a much broader range of alliances seen today" (p. 3).[2]

The increased number of interorganizational ties reflects a trend from self-sufficient firms to increasingly dense networks of interdependent firms linked by collaborative relationships.[3] While the motives for alliance formation are manifold, the recent spike in alliance activity coincides with a

---

[1] Cf. (Ernst&Young 2000)

[2] Of course, collaboration and alliances are not an invention of the 20th century. For instance, the Ancient Greek cities joined forces in the war against Persia, in 448 B.C. [cf. (Smith et al. 1995)]. Similarly, the Roman Republic (and later Empire) bestowed the title of 'friend and ally' upon associated peoples, without fully integrating these countries into its domain of power. With regard to the popularity of corporate collaboration, (Ohmae 1989) thus concludes: "Companies are just beginning to learn what nations have always known: in a complex, uncertain world filled with dangerous opponents, it is best not to go it alone" (p. 143). Among others, (Hergert and Morris 1988) provide empirical support for the exorbitant rise in collaborative activity.

[3] To make matters more complex, collaborating firms may also compete against each other in the marketplace. (Brandenburger and Nalebuff 1996) coined the term 'Coopetition' with regard to this phenomenon.

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rising complexity of conducting business, due to the foundations of competitive advantages becoming increasingly knowledge-based (rather than based on physical assets) and the scope of activities having become global. In addition to required skills and resources often exceeding individual firms' capabilities, this has also generated new collaborative opportunities. In brief, cooperative ventures have become an essential aspect of corporate strategy [e.g., (Ohmae 1989) or the articles in (Contractor and Lorange 1988b),].

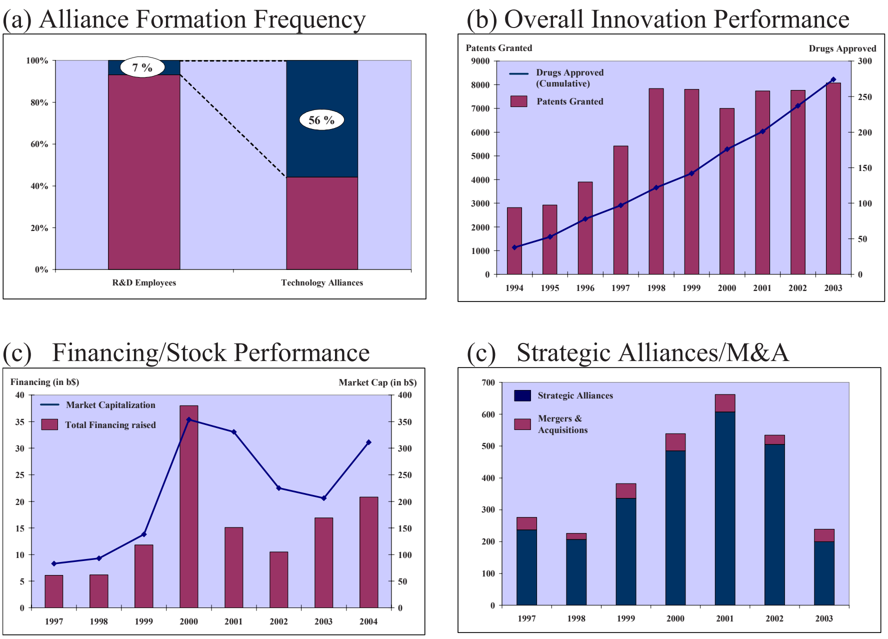
In no other industry collaboration is as integral a part of firms' business models as in biotechnology. Due to their relatively small size and early stage of development, dedicated biotechnology firms (DBFs) often depend on collaboration partners to finance their ongoing research activities and to commercialize the results of their work. Concurrently, established pharmaceutical firms (Big Pharma) rely on DBFs to complement their internal R&D efforts and to fuel their drug development pipeline [cf. (Zucker and Darby 1995), (Pyka and Saviotti 2001)]. As a consequence, collaboration between Big Pharma and DBFs has become an essential element of modern drug discovery operations [cf. (Arora and Gambarella 1990), (Whittaker and Bower 1994)]. While collaboration in other industries may merely represent one strategy to improve performance, it is a prerequisite for the survival of DBFs and to the commercial well-being of Big Pharma firms [e.g., (Uzzi 1996)]. The extraordinary importance of collaboration for biotechnology manifests in an overproportionally high frequency of alliance formation vis-à-vis other research-intensive industries [see Figure 1(a)].

Following the identification of the DNA structure in the 1950s, the development of the biotechnology industry has been streaky and volatile. The first (U.S.) DBFs were founded in the 1970s and some of them have evolved into today's powerhouses, i.e., large, fully integrated biopharmaceutical firms.[4] Continuous scientific advances in biotechnologies [see Figure 1(b)] were highlighted by the cloning of 'Dolly', a Scottish sheep, (by the Roslint Institute and PPL Therapeutics) in 1996 and the deciphering of the human genome (by Celera Genomics in association with the Human Genome Project) in 2003. In return, the wave of biotechnology

[4] Today's three largest biotechnology firms, Amgen, Genentech, and Biogen, were founded in 1980, 1976, and 1978, respectively. For more extensive reviews of the bio-pharmaceutical industry, refer to (Gambanos and Sturchio 1998) Similarly, the evolution of drug-discovery practices over time has been well documented by (Drews 2000), and (Grossmann 2003), among others. Also see (Watson and Crick 1953) on their Nobel-Prize winning discovery of DNA's Double-Helix structure.

IPOs in the early (U.S.) to late (Europe) 1990s reflected the increased commercial relevance of the industry.

Figure 1: Indicators of Biotechnology Industry Development[5]



Data sources: Bio, Ernst&Young, U.S. Patent & Trademark Office, OECD, NSF

Long regarded as one of the core technologies for the 21st century, biotechnology's success story was, however, tarnished by the stock market collapse in 2001. Several DBFs failed and or fell prey to takeovers due to being cash-strapped.[6] Additionally, numerous biotechnology alliances

5 Due to availability issues, the data in Figure 1(a), (b), and (c) refer to the U.S. market. The logic and pattern of both developments were, however, very similar for Europe. In light of the focus of this thesis, the data for Figure 1(d) was intentially limited to Europe, at the cost of no information on the pre-1997 period being available

6 Most notably PPL Therapeutics, the firm that 'sired' Dolly, was disbanded in 2003. At the same time, the increasingly frequent mergers and acquisitions in the biotechnology industry, do not, however, only reflect technological or commercial failure. They may in part be explained by economies of scale for more mature biotech firms or particularly low market capitalizations [cf. (Pollack 2003)]. Recently (September 21, 2006), one of Europe's largest

were dissolved (including deals as large as the one for blockbuster Avonex between Biogen and Shering-Plough) or led to unsatisfactory outcomes.[7]

These ups and downs of environmental conditions and firm development are reflected in the capital-market data presented in Figure 1(c). These substantial upsides and risks may also have an effect on collaborative activity, which followed a cyclical pattern reminiscent of the stock-market climate [in Figure 1(d)]. While corporate collaboration has always been an important empirical phenomenon in biotechnology, alliance formation thus appears to be affected by both continuous trends and discrete market developments.

1.2 Research Agenda

1.2.1 Research Objectives

The omnipresence of collaborative ventures, their particular importance in the biotechnology setting, and their interdependence with sector development (all observed in Section 1.1) characterize the point of departure for the present study.

The broad relevance of collaborative ventures in today's business world is reflected in the scope of research on the topic. While early studies were infrequent [e.g., (Evan 1965)], a plethora of contributions are now published in major journals and publishing houses each year. Scholarly publications have run special editions on alliances and networks, including the Academy of Management Journal (Vol. 40, No. 2, 1997), the Strategic Management Journal (Vol. 20, No. 2, 2000), and the Journal of Business Venturing (Vol. 21, No. 4, 2006).[8] While a comprehensive consideration of alliance-related arguments is outright impossible, the first objective of the present work is integrative. Based on an extensive selection of prior scholarly work, it intends to provide a framework for collaborative value

DBFs, Serono, was acquired by Merck KGaA for its strategic value [cf. (Anonymous 2006)].

7 As (Bleeke and Ernst 1993) document, failure and premature termination are the fate of many alliances regardless of industry. In the present context, however, alliance failure is a particular concern due to the pivotal role alliances play in firm development [see section 1.3.2].

8 At the same time, most previous research has focused on limited subsets of the theoretical wealth of explanations. While little surprising for article-length publications, this also applies to longer work, e.g., doctoral dissertations [e.g., (Merchant 1995), (Häussler 2005)].

creation. An assessment of the existing research shall 'clear the table' for future research efforts. Furthermore, the present work empirically documents the effectiveness of general value drivers for the European biotechnology industry.

Objective 1:	The thesis derives and empirically tests an integrative model of collaborative value drivers.

As biotechnology arguably is the industry most reliant on collaborative activities, it provides a suitable setting for studying the value of strategic alliances.[9] The present study aims to provide a detailed account of collaborative value creation in the European biotechnological industry. Generally, this entails using a homogeneous (single-industry) yet diverse (multi-country) data set of European biotechnology firms and alliances.

More specifically, the second main objective of this thesis extends to incorporating industry-specific influences. Rather than merely considering generic factors, specific value-drivers may allow deeper insight and enhance the overall power of value-related alliance research. This undertaking represents the first piece of research extensively analyzing specific value drivers for the biotechnological domain (as well as the first inquiry into the European biotechnology industry in general).

Objective 2:	The thesis assesses the value impact of transaction characteristics particular to biotechnological collaboration.

The apparent effect of biotechnology sector developments on collaborative activity suggests that environmental factors may substantially affect biotechnology-related alliances.[10] As its third objective, the present research ventures therefore aims to expand alliance research by addressing the influences on collaborative value exerted by institutional, market, firm, and

9 Indeed, much alliance-related research has used it as a background [e.g., (Lerner et al. 2003), (Baum and Silverman 2004)]. Some studies have even addressed the effect of collaborative agreements on pharmaceutical and biotechnology firm value [e.g., (Campart and Pfister 2003), (Karamanos 2002)]. While biotechnology collaboration thus has been extensively addressed in general, industry-specific aspects have been largely neglected.

10 More specifically, the context of collaborative agreements, including institutional, industry, and firm environments, may affect the benefits and stability of individual alliances [e.g., (Koza and Lewin 1998), (Park et al. 2002)]. Value-related research has only begun to consider such factors [e.g., (Park and Mezias 2005)].

alliance-inherent developments. This thesis is a novelty in fundamentally and systematically addressing these different aspects of collaborative value dynamics.[11]

Objective 3:	The thesis studies the effects of dynamic influences on collaborative value creation.

Figure 2 highlights the linkage of the three research objectives pursued in the present research to the fundamental observations of real-world alliance formation patterns. Furthermore, the three research objectives are closely interrelated. The common foundations of collaborative value creation (Objective 1) feed into the proposed empirical study. In addition to yielding generic determinants of collaborative value, existing research, i.e., theoretical arguments and prior empirical evidence, forms the basis for the assessment of context-specific (Objective 2) and dynamic value drivers (Objective 3).

This approach also determines the scope of the present research, since it does not entail deriving entirely new avenues of explaining collaborative value creation. Rather, it more specifically addresses existing theoretical foundations.

The outlined objectives are oriented towards enriching research on both strategic alliances and biotechnology firms. Specifically, alliance-related research may benefit from a scrutinizing review of prior achievements (Objective 1) and additional attention devoted to collaborative dynamics (Objective 3). In contrast, the empirical analysis of various general (Objective 1) and industry-specific factors (Objective 2) may provide additional insight into the source of biotechnological firm value.

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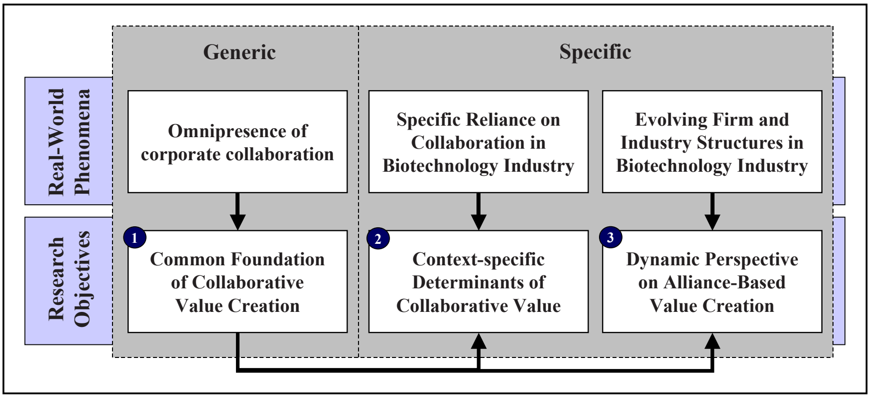
11 As further illustrated in subchapter 2.4, prior research touching upon collaborative dynamics tended to be explorative and focussed on individual forms of collaborative dynamics [e.g., case studies on alliance evolution presented by (Ariño and de la Torre 1998), among others].

Figure 2: Derivation of Research Objectives



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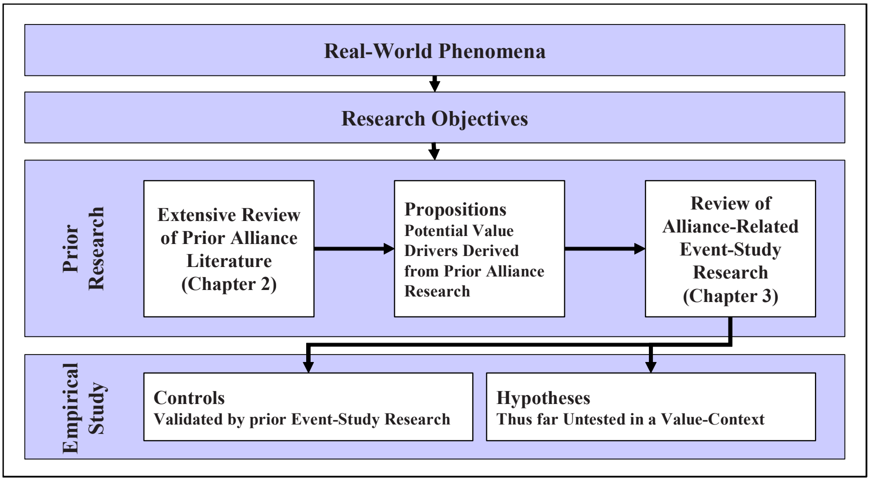
1.2.2 Research Approach

After clarifying fundamental concepts and definitions in subchapter 1.3, the present thesis proceeds in two main parts. As illustrated in Figure 3, the dissertation first addresses existing alliance research, before turning to original empirical work.

Figure 3: Key Elements of Research Set-Up



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Reviews of general and value-related alliance literature structure the research field and form the basis for the subsequent empirical study:

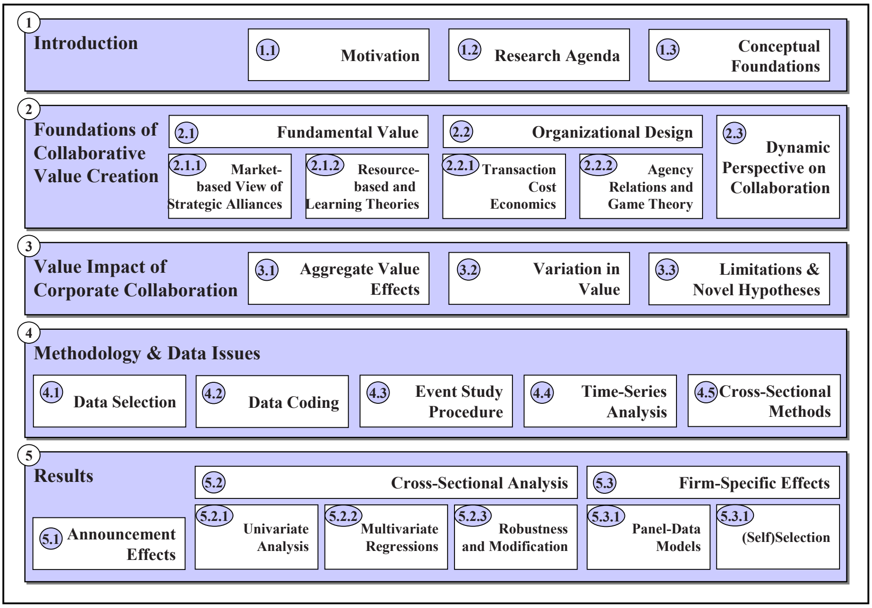
- *Chapter 2* reviews the different strands of literature on corporate collaboration. Due to the great wealth of existing literature on the topic, the scope of the review had to be limited to particularly influential contributions, published in reputable international publications. It culminates in a set of propositions, i.e., potential value drivers derived from prior alliance-related research. These propositions are rooted in economic and management theories as well as supported by general empirical evidence (i.e., effects on alliance formation and performance, but not firm value).
- *Chapter 3* contrasts the derived propositions with exiting value-related evidence. Such a review and assessment of prior event-study evidence on corporate collaboration is the first of its kind. Chapter 3 attempts to document existing insights into collaborative value creation as comprehensively as possible. Its main deliverables are two sets of testable assertions: Controls refer to the proposed factors previously found to affect collaborative value creation, whereas hypotheses address propositions not previously considered in a value-related context. Both build on the theory-based propositions

The second main part of this dissertation tests the empirical merit of the deduced controls and hypotheses:

- *Chapter 4* outlines the empirical methodology of the study. In particular, it discusses the data selection and coding processes, the event-study and cross-sectional methods, and the tests and safeguards used to assure the validity and reliability of findings. Furthermore, chapter 4 exceeds the scope of an ordinary methodology section by providing original approaches to the identification of sample firms and the empirically relevant drivers of biotechnology stock prices. These complementary analyses address the coherence of industry definitions and the overall drivers of biotechnology stock returns.
- *Chapter 5* presents the findings of the main empirical analyses. First, the announcement effects of various alliance-related events are assessed, which allows gaining insight into the evolution of collaborative value along the alliance lifecycle. Second, the observed valuation impact of alliance formation announcements is decomposed into generic value drivers (controls) as well as the hypothesized effects of industry-specific alliance characteristics, contractual provisions, and dynamic influences. Finally, these analyses are refined by validating the robustness of estimation, and controlling for firm-specific as well as self-selection effects.
- *Chapter 6* concludes by summarizing the main findings and placing them into perspective with regard to the primary research objectives, fu-

ture research, and corporate practice.[12] Figure 4 presents an overview of the dissertation structure.

Figure 4: Structure of Dissertation Thesis



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1.3 Conceptual Foundations

For a clear and unambivalent understanding of the subsequent literature reviews and empirical analyses, a brief introduction to the core terms and concepts underlying the present work may be helpful. This may also help to clarify the scope and nomenclature of the research. In sequence, the three constituents of the thesis title will be discussed: Collaboration, biotechnology, and value creation. While the other two aspects may be sufficiently generic to keep both sections concise, the biotechnology setting deserves some additional discussion. Specifically, the economics of biotech-

[12] Note that Figure 4 primarily is illustrative and does not detail the entire scope of the present work. Chapter 6 is not included for reasons of simplicity and legibility. Moreover, only substantive chapters and sections are shown, whereas sections summarizing the learnings derived from a given chapter or section are omitted. In particular, this affects subchapters 2.5 and 4.6.

nology are a necessary foundation for deriving industry-specific hypotheses and interpreting empirical evidence.

1.3.1 Definition: Collaboration and Alliances

Definitions of corporate collaboration are quite diverse.[13] As (Spekman et al. 1998) summarize, however, these definitions tend to converge with regard to their constituting elements:

- Collaboration is based on voluntary agreements between otherwise independent firms.
- Firms thereby pursue collaborative objectives, most commonly the pooling, transfer or development of resources.
- It requires a substantial degree of inter-firm coordination.

First, voluntary initiation of collaboration is a common feature of all alliance definitions, either explicitly [e.g., (Gulati 1995b), (Gulati and Zajac 2000)] or implicitly [e.g., (Spekman et al. 1998)]. Second, as independent firms voluntarily enter alliances, they clearly pursue common or at least non-conflicting goals. While the specific objectives may vary substantially among different alliances [see (Hagedoorn 1993) for an overview possible alliance goals], they commonly represent aspirations that cannot be achieve individually [cf. (Nueno 1999)].

While the first two elements thus are relatively straight-forward, the third one, interfirm coordination, has been subject of debate. For instance, (Gulati 1995b) explicitly excludes one-time co-marketing/distribution or technology transfer agreements, whereas (Gulati and Zajac 2000) include agreements involving the mere trading of resources (i.e., without long-term interaction). Reconciling these two perspectives, (Contractor and Lorange 1988a), (Hagedoorn 1990), and (Das and Teng 2000b) refer to different levels of interdependence in corporate collaboration. Specifically, (Das and Teng 2000b) distinguish bilateral and unilateral alliances depending on whether they draw on both firms' resources bases or represent a unidirectional transfer of resources (e.g., licensing).[14]

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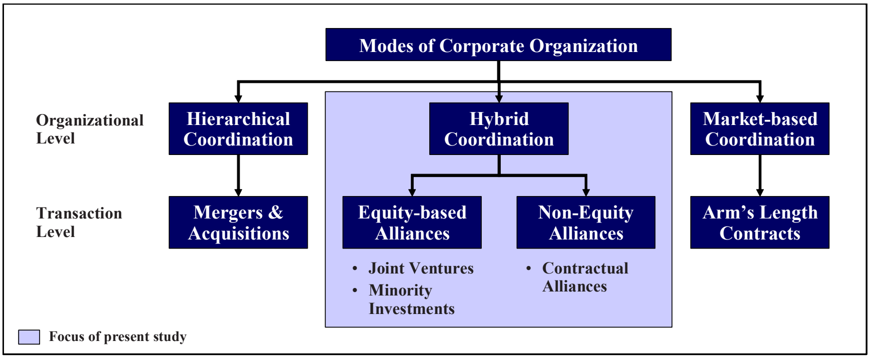
13 See Table 34 of the appendix for an overview of alternative definitions of collaborative activites.

14 (Contractor and Lorange 1988a) and (Hagedoorn 1990) take more finely grained approaches to the level of organizational interdependence. Specifically, joint ventures or equity-based collaboration and less formal modes of interorganizational governance (i.e., contractual collaboration) differ substantially in their economic implications, e.g. intra-alliance compensation.

Based on these three factors, the present study considers as collaborative ventures all *voluntary agreements between independent firms to jointly pursue complementary objectives*.[15]

As illustrated in Figure 5, this definition is distinct from other transactions enabling resource access or exchange, such as M&A or supply contracts. Conversely early work, including (McConnell and Nantell 1985) and (Borys and Jemison 1989) had considered these different transaction schemes under the joint headings of corporate combinations and hybrid arrangements, respectively. Arm's length transactions are excluded from this definition of collaborative ventures, since they do not induce a similar need to coordinate activities and are less driven by common interests. Similarly, M&A entails at least one of the firms involved ceasing to be independent [see (Balakrishnan and Koza 1993), (Hennart and Reddy 1997), (López-Duarte and García-Canal 2002), (Hagedoorn and Duysters 2002a), and (Vanhaverbeke et al. 2002) for studies contrasting M&A and strategic alliances].

Figure 5: Corporate Collaboration as Subset of Corporate Combinations



Source: Own Illustration

Consideration of strategic alliances extends beyond their individual formation in two respects relevant to the present study: On the one hand, forma-

15 For a similar definition, see (Häussler 2005). Note that, the terms collaboration and alliance as well as their derivatives (such as collaborative agreement, collaborative venture, strategic or inter-firm alliance) will be used synonymously throughout this thesis. To distinguish between the different organizational modes shown in Figure 5, the terms 'joint venture' (or JV) or equity-based alliance as well as contractual alliance (or collaboration) will be used. Table 34 of the appendix presents an overview of different levels of interdependence in collaborative ventures.

tion itself is only part of a broader alliance process. On the other hand, each alliance is embedded in the context of the firms' overall collaborative positioning.[16]

First, alliance formation is both preceded by preparatory activities and succeeded by operating activities. As outlined by (Spekman et al. 1998), extensive strategic analysis and partner screening are required prior to initiating collaboration. Furthermore, coordination, adaptation, and re-evaluation complement (pre-)formation in constituting an alliance lifecycle.

Second, the entirety of interfirm relations is often referred to as networks. At the same time, such a network holds importance in its own rights, since it provides a backdrop for further collaborative (but also all other firm) activity [cf. (Thorelli 1986), (Jarillo 1988)]. More generally, (Granovetter 1985) has dubbed the term of embeddedness to reflect that economic actions cannot be fully understood without reference to their social context. While the network perspective thus allows to consider interfirm relations more broadly [cf. (Gulati 1998)], the present study's primary interest lies at the dyadic level. Consequently, network aspects will be considered only to the extent that they affect individual alliances.

1.3.2 Setting: Biotechnology Industry

1.3.2.1 Biotechnology Firms and the (Bio)Pharmaceutical Industry

Broadly defined, biotechnology encompasses all applications of biological systems and processes [cf. (Christensen et al. 2002)]. This clearly includes fermentation (e.g., in beer brewing) and the cultivation of crops or breeding of animals. More recently, (BIO 2005) defines "new biotechnology [as] the use of cellular and biomolecular processes to solve problems or make useful products" (p. 1)[17]. Potential applications of 'new' biotechnological knowledge are multifaceted. Specifically, they relate to human health (red biotechnology), agriculture, forestry, and life-stock breeding (green biotechnology) as well as industrial uses (white biotechnology) and environmental protection (gray biotechnology). Dedicated biotechnology firms (DBFs) are for the most part active in human-health-related applica-

16 At this stage, dynamic alliance processes and network effects are only touched upon to provide a complete picture of the study object. These issues are further elaborated in subchapter 2.4.

17 (Mathios 1998) provides a similar definition of biotechnology: "The application of science and engineering in the direct use of living organisms, or parts, or products of living organisms in their natural or modified forms." (p. 357)

tions. In fact, many researchers with an interest in the economics of biotechnology either explicitly [e.g., (Grossmann 2003)] or implicitly [e.g., (Häussler 2005)] limit themselves to this segment. Since the targeted analysis of industry-specific collaboration characteristics favors a crisp industry definition, the present study follows suit: All further biotechnology references and analyses pertain to 'red biotechnology' only.[18]

In turn, 'red biotechnology' is largely synonymous with biopharmaceutical research and development (R&D), i.e., the development of diagnostics and medications using biotechnologies. Governed by technological necessities and regulatory obligations, biopharmaceutical R&D follows a stringent process model. Figure 6 provides an overview of various biotechnological applications in this domain.[19]

In the research phase, molecular targets associated with a given disease and active ingredients showing in vitro activity on them are identified. Following the optimization of the resulting drug candidates, the development phase is initiated by testing the candidates in different model animals. Only after showing in vivo activity and tolerability in these animals, the three-stage clinical testing process begins. Upon the successful conclusion of phase III clinical trials, drug candidates are submitted for regulatory approval and may then be introduced to the market.[20]

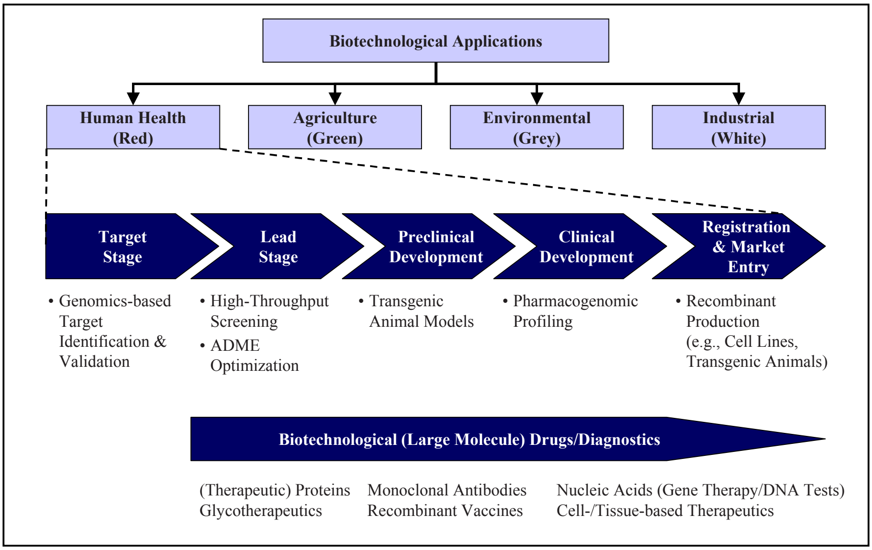
---

18 While all firms in the empirical sample later analyzed in this study primarily operate in the 'red biotechnology' sector, some alliances may relate to other applications (e.g., animal health). These are coded as 'others' in the general event study (subchapter 5.1) and excluded from the cross-sectional analysis (subchapters 5.2-5.4)

19 For more in-depth reviews of biopharmaceutical applications in drug discovery, see (Tollman et al. 2001), (Grossmann 2003), and (Ng 2004).

20 FDA (Food and Durg Administration) regulation in the U.S. or the German Law on Pharmaceuticals (Arzneimittelgesetz) set high standards for new medication to gain marketing approval. In addition to tolerability and effectiveness, they generally need to show efficacy relative to existing treatments for a given indication.

Figure 6: Biotechnological Applications



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While biotechnological methods have gained access to all stages of the drug discovery pipeline (see Figure 6), two applications deserve particular mention:

- Genomics-based target identification has revolutionized pharmaceutical drug discovery. Previously, new drugs were developed based on compounds already having shown activity (in other indications) or accidentally exhibiting a certain effect [cf. (Drews 2000)]. In contrast, genomics allow researchers to address the root causes and understand the pathways of disease progression.[21] Therapeutics showing activity on the corresponding targets may present increasingly better cures for these diseases. The resulting acceleration of drug discovery and reduction in the failure rate of drug candidates may lead to substantially lower costs of drug development (30-40%) and time to market (as much as 15%) [cf. (Kayser and Müller 2003), (Tollman et al. 2001)]. Additionally, the sheer endless number of genetic targets for drug discovery holds the potential to find treatments for previously incurable diseases.

[21] (Tollman et al. 2001) further distinguish genomic, chemical genomics, and genetic target discovery. Additionally, scientific advances allow researchers to more fully understand the chain of physiological reactions underlying disease progression. The knowledge of such ‘pathways’ enables them to prioritize most promising drug targets.

- Biotechnology also has given rise to entirely new classes of therapeutics and diagnostics. The importance of such new biological entities (NBE) has increased continuously, whereas the number of new chemical entities (NCE) has been on the decline in recent years [cf. (DVFA 2005)].[22] More importantly, they may provide effective treatments for hard-to-cure diseases, such as autoimmune, neurological, or oncological disorders. (Kayser and Müller 2003) estimate that by 2050, 15% of all worldwide pharmaceutical sales may stem from biological drugs or vaccines.

Biotechnological approaches thus allow to both identify the locks to better disease treatments (targets) as well as potential keys (leads).[23] Other important biotechnological application in the pharmaceutical industry include drug production technologies [e.g., (Mallik et al. 2002)], rational drug design[24], and pharmacogenomic profiling of clinical trial patients [e.g., (Anonymous 2003), among others].

As mentioned previously (section 1), the major pharmaceutical firms were slow and ineffective in picking up new biotechnological ideas, primarily due to their almost exclusive focus on chemistry-based drug discovery. From their perspective, collaboration with biotechnology firms substituted for internal R&D in these new research areas [cf. (Zucker and Darby 1995), (Prevezer and Toker 1996)].[25] Additionally, biotechnology firms formed a linkage between the basic research findings often derived

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22 Traditional NCEs are also referred to as small molecule drugs due to their lower molecular weight. (Christensen et al. 2002) further differentiate NBEs into proteins (including antigens/vaccines), antibodies, nucleic acids, glyco-therapeutics and cell-/tissue-based therapeutics. Chemically, most of these entities are composed of amino-acids and thus are proteins. Consequently, the aforementioned term therapeutic proteins only refers to those protein-based therapeutics not included in one of the more specific categories.

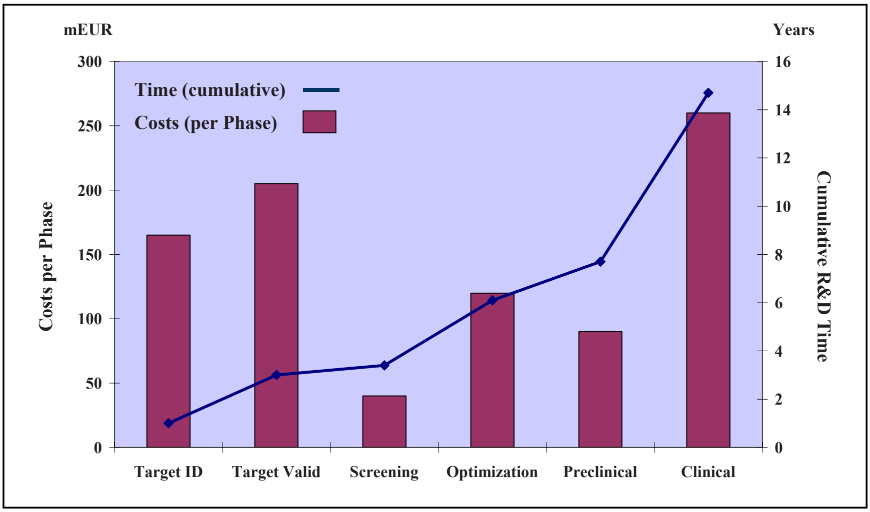
23 For a more extensive discussion of this 'Lock and Key' analogy, cf. (Grossmann 2003) and (Ng 2004)

24 In this context, (Anonymous 2003) as well as (Grossmann 2003) elaborate on interative processes (i.e., the rescreening of alternative moderations of a given active substance to arrive at yet more powerful drug candidates) and structural drug design, which attempts to configure the chemcical (spatial) structure of the lead to optimally fit to the target. Additionally, both approaches may be used to optimize the drugs ADME properties

25 As (Gambanos and Sturchio 1998) find, several Big Pharma firms did not even build general biotechnological know-how internally, thus effectively relying on collaboration with biotech firms. Those, who chose to internalize such knowledge, often acquired biotech firms as basis of their biotechnology activities.

by academic institutions and the application-oriented perspective of Big Pharma firms. More recently, biotechnology collaboration has become an essential tool for Big Pharma to overcome the shortage of new product introductions limiting its continuing growth and endangering its relatively high stock valuation [e.g., (Mallik et al. 2004)]. In particular, the high rate of attrition among drug candidates necessitates external sourcing to fill drug pipelines. About 10’000 substances evaluated in the drug discovery stage on average correspond to one new drug eventually introduced to the market [cf. (PhRMA 2003)]. Additionally, the long time-to-market renders insourcing an attractive solution for filling internal gaps. Figure 7 numerically substantiates these arguments.

Figure 7: Time and Cost Economics of Biopharmaceutical Drug Discovery



Data Source: (Tollman et al. 2001)

On the opposite side of the medal, small DBFs are equally reliant on big pharma partners. While their validated drug targets and lead candidates are the cornerstones of successful new drug development, they often lack the resources to independently progress these projects through the development cycle. In particular, the large-sample trials required in later clinical stages as well as the scale-up of manufacturing processes and the fixed costs of building a proprietary salesforce are often outside their capabilities. As a consequence, Big Pharma alliances have long been an important mechanism for DBFs to refinance and commercialize their scientific progress as well as to validate their otherwise unobservable quality characteristics [e.g., (Pisano and Mang 1993), (Nicholson et al. 2002)]. Young and small biotechnology firms may also resort to collaborative service agreements and technology outlicensing to gain the financial means necessary for further firm development. As such, drug discovery, service provision, and platform technologies are the prevalent business models in the biotechnology industry [e.g., (Höger et al. 2004)].[26]

All in all, the core capabilities of biotechnology and Big Pharma firms are highly complementary. While biotechnological skills are best applied during (early) drug discovery stages, the commercial experience and resources of Big Pharma firms give them an edge in (later) clinical drug development, registration, and commercialization.[27]

In addition to explaining the occurrence of pharma-biotech alliances, these motives also affect their structure and the relative bargaining power of collaborating firms. On one hand, a relatively small number of Big Pharma (or large biotech) firms possesses the skills and resources to swiftly and resoundingly lead drug candidates to the market [cf. (Roberts 1999), (DiMasi 2000), (Malerba and Orsenigo 2002)]. Conversely, platform technologies and research services may be offered by a broader range of firms and may be more easily replicable, which makes them less valuable and decreases the provider firms' bargaining power [cf. (Höger et al. 2004), (Fisken and Rutherford 2002)].[28] On the other hand, extraordinary drug candidates may allow their originator to negotiate favorable collaboration terms. Along these lines, (Coombs and Deeds 2000) observe substantially higher compensation for advanced stage projects, which have already proven themselves in clinical trials.[29]

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26 Alternative business model classifications may be cruder [e.g., (Fisken and Rutherford 2002), who only distinguish products (i.e., drug), platform technologies and hybrids] or use even more fine-grained [e.g., (Grossmann 2003)]. Figure **45** in the appendix assigns the various biotechnological approaches to different business models.

27 (Henderson and Cockburn 1996) trace this to fundamental differences in the nature of drug discovery and drug development. Whereas drug discovery remains a diffuse actvity, effectively based on the principle of ' trial and error', drug development is much more structures, since it is heavily regulated by governmental registration provisions. Also see FN 20.

28 Technology or service provision were earlier deemed equally viable business models vis-à-vis proprietary drug discovery. Recent trends have seen most firms abandon pure-play technology or service strategies in favor of own drug discovery activities or hybrid forms [e.g., (Anonymous 2003)]. Some firms, however, compete successfully by providing state-of-the-art process technologies [e.g., Qiagen] or biopharmaceutical services [e.g., Evotech OAI] due to superior skills and technologies.

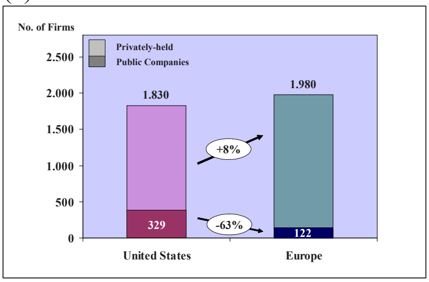
29 Also see subsection 2.2.2.2 as well as FN79.

1.3.2.2 The European Biotechnology Industry

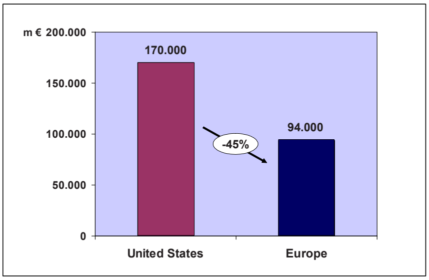
Overall, biotechnology thus may play an important role in the (bio)pharmaceutical industry, commercially as well as scientifically. On average, biotechnology firms, however, remain small and with some notable exceptions are not fully integrated along the value chain (i.e., having proprietary production facilities, sales and marketing organizations). Since the present study is set in the European biotechnology industry, the situation also needs to be assessed from an international perspective.

Figure 8: Comparison of U.S. and European Biotechnology Industries

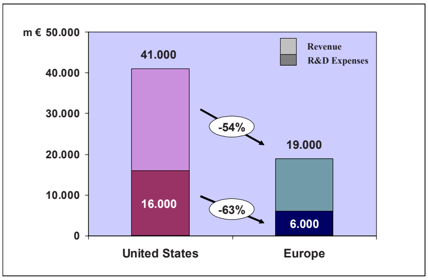
(a) Number of Firms



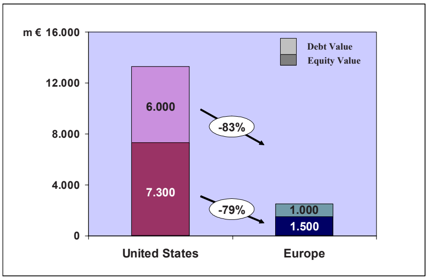
(b) Number of Employees



(c) Commercial Performance & Innovation



(d) Financing & Stock Performance



Data Source: (Critical-I 2005)

Given the numerous studies set in the U.S. biotechnology industry [e.g., (Rothaermel and Deeds 2004), (Yao and Ge 2002)], it is a suitable benchmark. In brief, comparison along almost any dimension leads to the conclusion that the European biotech industry by far lags its U.S. counterpart. In interpreting the data presented in Figure 8[30], (Critical-I 2005) summarizes that "at present, European biotechnology even when being taken col-

30 Financial numbers (R&D spending, revenues, equity, and debt) are given in million Euros (€).

lectively does not ‘compete’ with the U.S. sector in the sense of being on par with it by any measurable value with the exception of company numbers” (p. 5). Indeed, the overall number of biotech firms is quite similar in Europe and the U.S.. Differences start with the number of publicly listed firms, which is about twice as high in the U.S.; their equity value even towers over European DBFs’ fivefold. Evidence is similar for operating and financial figures, such as the number of employees, R&D spending, revenues or debt capacity.

Potential reasons for the limited development of the European biotechnology industry are multifaceted. Three factors most prominently figure into the equation:

- Many European countries may have been late in establishing the legal framework and incentives prerequisite for the initiation of a biotechnology industry. Studies on the evolution of (regional) biotechnology clusters have shown that the early set-up phase most critically depends on governmental funding [e.g., (Steiner 2001)]. Additionally, many Continental-European countries did not have adequate legal environments for the establishment of biotech firms at least until the 1990s [e.g., (Häussler 2005) for Germany].
- Once a technological basis exists, private funding is required for the further development of DBFs. For Continental Europe, the development of financial markets has been lagging behind Anglo-Saxon countries. For instance, the German venture capital industry effectively did not exist until the mid- to late 1990s [cf. (Fiedler and Hellmann 2001)], which was instrumental in developing the German biotech industry [cf. (Champenois et al. 2004)]. Similarly, the first market segment of a Continental-European stock exchange targeting high-growth firms, the ‘Nouveau Marché’, was not introduced until 1996.
- Finally, unsupportive public perception may continue to hinder the development of the European biotechnology sector (e.g., by favoring legal restrictions). While this most strongly relates to ‘green’ biotech applications, in particular genetically modified food [cf. (Chen and McDermott 1998)], ethical concerns also remain with regard to ‘red’ biotechnology. In addition to the well publicized dispute on stem cell research, negative public perception also concerns the use of personal (e.g., pharmacogenomic) data [cf. (Caulfield 1998)].

In combination, these factors constitute an institutional setting inconductive for the development of the European biotech industries. Nonetheless, Europe easily represents the second largest biotechnology sector worldwide. Specifically, it is home to 18% of all publicly listed biotechnology firms, whose revenues amount to 15% all biotechnology sales [cf.

(Ernst&Young 2006)]. Given the similar share of publicly listed firms and corresponding sales, the size of European DBFs should be close to the worldwide average.[31] In total, the European biotechnology industry thus may be distinctly lagging behind the U.S., but further along than usually given credit for.

Furthermore, Europe, while often being treated as an entity, is quite heterogeneous across country borders. Figure 9 compares the number of public biotechnology firms and the number of drug development projects they have in clinical trials across the most important European countries.[32]
Most striking is the dominant position of the U.K, which hosts over 40% of public European DBFs (46%) and drug candidates in clinical trials (42%). Switzerland is home to the second most advanced industry (in terms of drug candidates), whereas Germany's biotech sector is the second largest (measured as the number of public firms). Each is relatively weak in the respectively other dimension.[33] France and Sweden assume intermediate positions, followed by Demark, the Netherlands, Norway, and Ireland.

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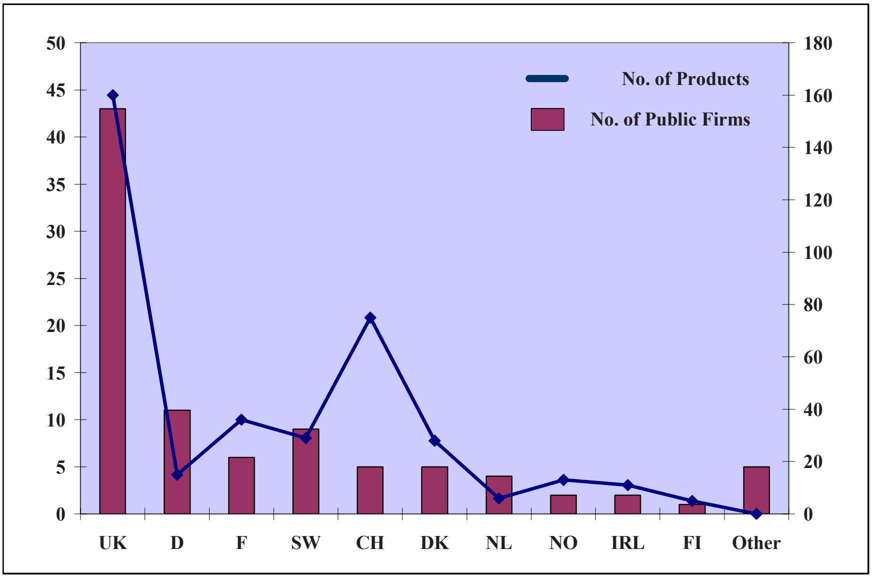
31 Figure 46 of the appendix presents the data comparison on public biotechs in the U.S., Europe, Canada, and the Asia/Pacific region. In particular, the U.S. and Asia/Pacific are quite opposite. While the U.S. has the most firms, they contribute overproportionally to the Global sector revenues (76%). The Asia/Pacific region is much less consolidated, evidenced by a high number of small public firms. The comparison to Canada is similarly relevant, since some alliance-related research has used is as a setting [e.g., (Baum and Silverman 2004)]. In terms of revenue, Canadian biotechs are on average substantially smaller than the European firms.

32 Note that the number of biotechnology firms identified in the (EuropaBio 2005) study may differ substantially from other sources and from the sample considered in the present work. See section 4.1.1 for a comparison of different industry classifications.

33 The data in Figure 9, however, is limited to public biotech firms and proprietary drug development projects (as indicators of firm development). Figure 48 in the appendix provides further evidence on the differing nature of biotechnology industries across European countries. Particularly, it indicates a specific pattern for Germany, which exhibits the highest share of biotechnology firms (public and private) as well as of governmental subsidies among all European countries. Germany also has the lowest share of drug discovery firms (vs. technology or service providers) among all European countries [cf. (Ernst&Young 2006)]. This leads to numerous collaborations (second-place finish), but does not add drugs to the national pipeline.

Figure 9: Cross-Country Comparison of Biotechnology Industry Development



Data Sources: (EuropaBio 2005)

Similar to the U.S.-Europe comparison, heterogeneous Intra-European development may result from differences in capital-market development, legal restrictions, and public support for biotechnology, among other factors. All in all, the cross-country data suggests that most European countries' biotechnology industries have a similar state of development. In contrast, the UK appears to be the solitary leader on the way towards closing the gap to the U.S..

With regard to the further course of this study, it may be noteworthy that – with the above exceptions – the state of national industry development appears to be commensurate with the number of publicly listed biotechnology firms. Consequently, a study of public DBFs from different European countries effectively weighs these countries based on their level of industry development. However, this does not cause any undue distortion, since this stratification is not artificial, but a constituting characteristic of the overall market.[34]

[34] Similarly, prior research has usually disregarded regional clustering in national studies.For instance, hotbeds of biotechnology activity in the U.S. are California (San Francisco/Silicon Valley and San Diego areas) and Massachussets (in particular, the Cambridge area). Unless explicitly considering the effect of location within such a cluster [e.g., (Coombs and Deeds 2000),

1.3.2.3 Characteristics of Biotechnology Alliances

The differing industry structures and resource endowments of the pharmaceutical and biotechnological domains suggest that DBFs mostly supply innovations to Big Pharma firms in return for financial considerations. Yet, other alliances have also formed, composing a broad range of different collaboration schemes. While no generally accepted typology exists, five main dimensions characterize biotechnology alliances. As illustrated in Figure 10, this includes the (industry and geographic) scope of collaboration, the relatedness of partners, the strategic objective of the alliance, and its structural characteristics:[35]

- While in many settings, alliances span beyond the boundaries of individual industries, the majority of biotechnology alliances is intra-industry. In particular, the vast majority of such alliances link two (or more) players in the bio-pharmaceutical industry [see Figure 10(a)]. While this may be a direct result of most biotechnology firms focusing on human health applications, firms in other subfields (e.g., green biotechnology) will also tend to collaborate within those domains.
- As the biotechnology sector is knowledge-driven, physical proximity is not important in biotechnology alliances. Specifically, European firms collaborate commonly collaborate across borders, most often with partners from the U.S. [see Figure 10(b) for details]. Given the advanced stage of the North American biotechnology industry, this predominance of transatlantic collaboration is reasonable.
- Relatedness in most industries refers to collaboration with competitors (horizontal), suppliers (upstream) or customers (downstream). In biotechnology, the positioning of firms and institutions along the drug development path may be more important than physical buyer-supplier relationships. For instance, the core knowledge of Pharmaceutical firms lies in areas (e.g., clinical trials) downstream from the genomics and proteomics expertise of DBFs. Consequently, both are related with Big Pharma building on the achievements of DBFs. Similarly, DBFs profit from (upstream) basic research conducted by universities or research institutions and work at the same level of knowledge production as other

(Owen-Smith and Powell 2004)], the relative share of firms from any one region determines its weigth in the overall sample.

35 Note that even generic alliance topologies are rare, since most authors focus on individual aspects of collaboration. The present study builds on a model proposed by (Vyas et al. 1995) [see Figure 49 in the appendix for the original framework], which, however, requires extension for the sake of completeness and adaptation to the biotechnology context.

DBFs. Figure 10(a) illustrates that such horizontal alliances make up a significant share of collaboration, similar to downstream alliances with pharmaceutical firms.

- The primary objective of an alliance may generally be technology- and/or market-related [e.g., (Vyas et al. 1995)]. For biotechnology collaboration, technological development and commercialization are closely intertwined. In particular, the biotechnological applications discussed above (see Figure 6, p. 14) may be technologies used to support further (collaborative) R&D, but they themselves may also be commercialized. The distinction of technology- and/or market-related alliances thus depends on the business models pursued by the DBF [e.g., (Fisken and Rutherford 2002)]. Other biotechnology-specific transaction characteristics include the stage of collaboration (or state of technology) [e.g., (Rothaermel and Deeds 2004)] and the direction of resource flows between transaction partners[36] [e.g., (Combs and Ketchen 1999b)].
- Finally, the organizational design constitutes an important aspect of alliances. As discussed in section 1.3.1, joint ventures may be distinguished from contractual alliances. While JVs are relatively uncommon in biotechnology partnering, minority equity stakes [e.g., (Filson and Morales 2004)],[37] contractually specified incentive and control mechanisms [e.g., (Robinson and Stuart 2002)] as well as compensation provisions [e.g., (Christensen et al. 2002)] are important alliance features.

The five dimensions of collaborative ventures discussed above allow characterizing alliances. While the section highlighted some attributes predominant in the biotechnology setting, each collaborative venture is distinct and needs to be assessed. The typology developed here may serve as a framework for such analyses.

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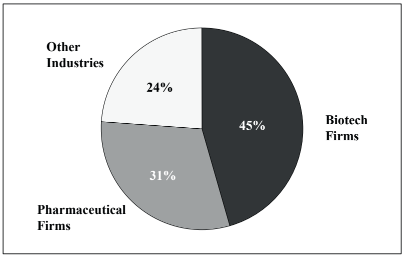
[36] While the relatedness of core knowledge implies a natural direction of resource flows, the actual roles of alliance partners may vary significantly. For instance, pharmaceutical firms may outlicense technologies or drug candidates to biotech firms, especially in small-market indications. Similarly, universities and research institutions may purchase technologies for internal use. Consequently, the notion of (core knowledge) relatedness is distinct from the direction of resource flows.

[37] While little recent evidence exists on the share of JVs, contractual alliances appear to dominate in biotechnology. While (Filson and Morales 2004) indicate that up to 16% of biotech alliances include minority equity stakes, data provided by (NSB 2006) suggests that equity-based governance has been historically less common than in other industries and has recently dropped to below 5%. See Figure 10(d) for details.

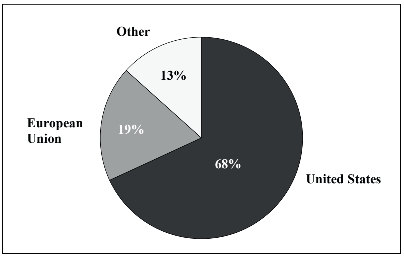
Figure 10: Market Statistics on Biotechnology Alliances

(a) Intra-Industry



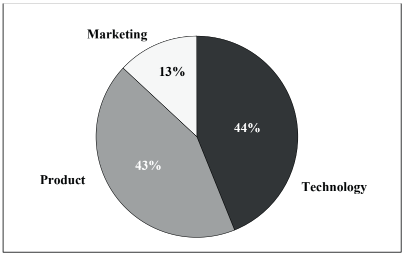
Data Source: (Ernst&Young 2004)

(b) International



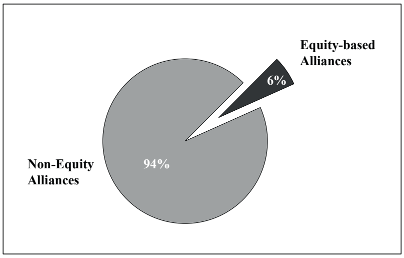
Data Sources: (EuropaBio 2005)

(c) Focus



Data Source: (Ernst&Young 2004)

(d) Share of JVs & Equity-based Governance (1997.2003 avg)



Data Source: (NSB 2006)

1.3.3 Measure: Collaborative Value

Further research addressing strategic alliances (as defined in section 1.3.1) in the European biotechnology industry (introduced in section 1.3.2) may take various angles on the topic. In general, such research may relate to the motivation for collaboration, to behavioral aspects, such as the choice of collaboration partners and structures, as well as to performance implications.[38] The latter abstractly refers to the contribution of the given collaboration to the achievement of the firm's overall objectives.

Addressing the corporate objective function, (Jensen 2001) concludes that "managers must have a criterion for evaluating performance and deciding between alternative courses of action, and that that criterion should be maximization of long-term market value of the firm. […] This Value Maximization proposition has its roots in 200 years of research in econom-

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38 Figure 47 in the appendix provides an overview.

ics and finance" (p. 8).[39] The present study sides with this view to the extent that it uses a shareholder value measure to empirically approximate the concept of collaborative value.[40]

The alternative, stakeholder theory, holds that all constituencies' interests should be represented in corporate decision-making. In a collaborative context, (Zajac and Olsen 1993) argue that collaborative value maximization explicitly requires considering the value sought by transaction partners rather than only taking an individual firm perspective. (Blankenburg-Holm et al. 1999) provide a similar model of collaborative value creation, which views mutual commitment and dependence as mediating constructs linking it to the mere existence of network relations. For the purpose of this study, the shareholder value effect of alliances thus reflects net value creation, after accounting for stakeholder interests protected by explicit or implicit contracts. The latter represent the costs of ensuring collaboration.

Shareholder value may be measured using different formal methods, ranging from the standard DCF model [e.g., (Copeland et al. 2000)] to elaborate option-pricing models [e.g., (Trigeorgis 1996)]. Most alliance-related research has (implicitly or explicitly) assumed a standard DCF framework of corporate value. For instance, (Zajac and Olsen 1993) refer to collaborative value as "maximizing net present value in exchange relationships" (p. 137). However, (Madhok and Tallman 1998) distinguish the potential value attainable from the realized transaction value net of relationship-specific investments. As a result, the value of collaborative arrangements may be incorrectly specified as the NPV of a set of (expected) future cash-flows, even after accounting for the costs of cooperation. Specifically, since collaborative structures may be more easily adapted than hierarchical ones, the flexibility alliances provide may be valuable. (Kogut 1991) refers to these flexibilities as real option.[41] As conceptualized in

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39 At this general level, the focus on the market value highlights that, in the long run, value needs to be realized in the marketplace. Similarly, even (Marx 1967) concedes that the (outward) value of goods manifests in market-based exchanges, i.e., in relation to other goods. Conversely, he identifies the (true) value of goods to derive from the quantity of human labor associated with its production.

40 Other assumptions underlying the event-study method, e.g., capital market efficiency, are addressed in section 4.3.3.

41 See section 2.4.1 for further details on the flexibility value of collaboration. It should also be noted that the value of pharmaceutical R&D also in part results from such flexibilities (e.g., options to abort unsuccessful R&D projects). The theoretical appeal of option-pricing models thus is evident [e.g., (Pritsch 2000), (DVFA 2005)]. However, real-world applications remain uncommon [e.g., (Sender 1994), (Höger et al. 2004)].

Equation (1), collaborative value is thus composed of three aspects: General (gross) collaborative benefits, the costs (or investments) required to ensure cooperation, and the value of flexibility.

$$V_C = V_{NPV} - I_{Coop} + V_{Flex} \tag{1}$$

Prior to focusing on the actual value impact of alliances, Chapter 2 further builds on these three underlying factors. On one hand, it considers the sources of (potential) value creation (V_{NPV}) as well as the limitations of collaboration and the costs of assuring cooperative behavior (I_{Coop}). On the other hand, it also outlines the dynamics of collaborative benefits, which form the basis of any flexibility value (V_{Flex}). These three aspects may be expected to empirically affect the observed returns to alliance announcements.

2 Foundations of Collaborative Value Creation

"No organization – no matter how big or how smart – knows as much as two organizations (or as much as an alliance network)."

(Conlon and Giovagnoli 1998), p. 183-4

2.1 Introduction

As (Gulati and Zajac 2000) summarize, "it is hard to think of any issue that has been the subject of greater research in the last decade than that of strategic alliances" (p. 365). This extensive interest is manifested in a broad range of prior research. In their meta-analytical study, (Oliver and Ebers 1998) identify 17 different theories which have been applied in research on strategic alliances and corporate networks.[42] This plethora of different approaches also reflects the lack of a coherent theoretical basis. Consequently, the scope of existing research needs to be clarified before moving onto further research. More specifically, value-related alliance research can only be assessed (let alone extended), once the basic mechanisms of collaboration have been settled. With this objective in mind, the present chapter reviews existing literature on the topic and derives a set of propositions, i.e., potential mechanisms of collaborative value creation. In doing so, it addresses both alliance formation and performance as mediating constructs

[42] The specific findinds may not be applicable to the present context due to (Oliver and Ebers 1998) focus on strategic networks (rather than alliances more broadly), time horizon (ending in 1996), and sources (limited to the four leading journals in organizational research, excluding e.g., the Strategic Management Journal, Organization Science, the Journal of Management). However, the diversity in this comparably limited arena suggest that the wealth of theoretical foundations may not be comprehensively addressed by any one study.

H. Farag, *Collaborative Value Creation*,
DOI: 10.1007/978-3-7908-2145-1_2,

for the ultimate prize, collaborative value creation.[43] Consequently, all propositions follow the following general logic:

Alliance Motivation/Formation
→ Alliance/Firm Performance
→ Collaborative/Firm Value

Several review articles, among others by (Kogut 1988b), (Oliver 1990), (Parkhe 1993a), (Osborn and Hagedoorn 1997), (Spekman et al. 1998), (Barringer and Harrison 2000), and (Gulati et al. 2000), have provided both structure and direction to the research of strategic alliances. Many of these reviews and much of scholarly research in general have addressed a similar selection of fundamental theories, which may thus be considered as the core aspects of strategic alliance research.[44] These include the internal and external sources of collaborative benefits, the costs of ensuring cooperative behavior, and institutional aspects of alliance activity. Building on these precedents, this chapter is structured around five main streams of research: The market- and resource-based views of corporate strategy, transaction and agency cost theories, and a dynamic perspective on collaborative benefits. The first two purely address the strategic effectiveness of strategic alliances (subchapter 2.2); the subsequent two focus on the efficiency of transaction structures (subchapter 2.3). Finally, both effectiveness and efficiency dimensions are subject to changes over time (subchapter 2.4). Figure 11 provides an overview.

While prior literature reviews represent the reflections by highly prominent alliance-scholars, they differ from the overall perspective of the present work: On the other hand, they do not directly aim at explaining collaborative benefits, but rather give a high-level account of the overall state of research. On the other hand, since most influential reviews date back several years, they do not sufficiently capture recent advances in alliance research. For instance, contractual alliance structures and option-characteristics were previously referred to as gaps in the existing literature

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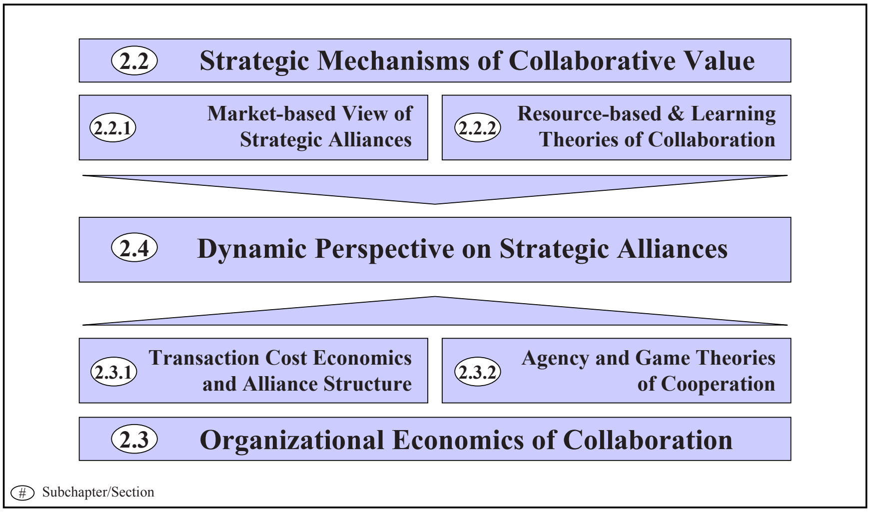
[43] Note that this section explicitly does not consider value-related evidence, which will be assessed in greater detail in chapter 3. Naturally, operating and financial performance benefits of strategic alliances should translate into increased firm value. Similarly, alliance formation provides access to such benefits.

[44] See Table 36 of the appendix for an overview. Difference exist with regard to the terminology used, but less so in terms of actual content. Alternatively, some reviews, e.g., (Spekman et al. 1998), use a process-oriented approach distinguishing alliance formation, management etc..

[e.g., (Spekman et al. 1998) and (Gulati et al. 2000), respectively]. This encourages or even necessitates a further review of existing research.

Figure 11: Overview of Theoretical Foundations



Source: Own Illustration

While the present work by no means claims to be comprehensive, it provides an overview of the most important theoretical arguments. More importantly, it adds to the existing body of literature reviews in two ways: First, it takes an integrative approach by stressing the complementary nature of these theories. Second, by considering both theoretical concepts and the empirical evidence, it derives a number of generally validated propositions with regard to collaborative value creation.

2.2 Strategic Mechanisms of Collaborative Value Creation

2.2.1 Market-Based View of Strategic Alliances

2.2.1.1 Industrial Economics and the Strategy Logic of Collaboration

The first corporate strategy framework developed the general notion of strategy being about matching a firm's goals and competencies with its environment [(Learned et al. 1969)]. The latter encompasses external opportunities and threats as well as broader societal expectations facing the company. The resulting ‘strategic fit’ has become one of the most fundamental concepts in corporate strategy [cf. (Grant 1998)]. As all corporate strategy, the general benefits of strategic alliances may thus be associated with two distinct perspectives. On one hand, they may aid in navigating the competitive challenges inherent in a firm’s environment. This is the view taken by the market-based approach. On the other hand, alliances may build on and foster firm resources, i.e., the firm-specific sources of competitive advantages. The two approaches thus represent complementary ‘outside-in’ and ‘inside-out’ perspectives.

Industrial economics research has focused on the important role the industry environment plays in explaining firm performance. Building on (Bain 1964) and (Mason 1939), the traditional structure-conduct-performance (SCP) paradigm has dominated this line of reasoning. Following standard microeconomic logic, the SCP paradigm argues that firm conduct (i.e., strategy) and, as a result, firm performance are largely determined by industry structure.[45] Specifically, monopolistic and oligopolistic settings allow firms to reap greater profits than conditions of perfect competition. In such cases, firms will choose output levels below market clearing, while maintaining artificially high price levels.[46] In this context, strategic alliances may serve as a mechanism to coordinate firm interests, either explicitly (cartels) or by reducing the hostility of competition.

45 At the same time, the SCP paradigm has been expanded to include a feedback loop accounting for the effects of corporate strategies and performance on industry structure. Within the scope of the present study, such feedback effects are of limited importance. While some collaborative ventures may indeed affect industry structure (e.g., the recently postponed JV of Siemens and Nokia with regard to telecommunication networks), prior research focussed on the primary effects of industry structure on the choice and performance of alliances (see the following subsection). Furthermore, biotechnology collaboration generally does not affect industry structure, given the generally small size of companies and the predominance of alliances focussing on individual drug discovery projects (i.e., not affecting companies as a whole).

46 Various empirical studies have attempted to quantify the impact of industry factors on corporate performance in general. As summarized by (Bowman and Helfat 2001) and (Ruefli and Wiggins 2003), among others, industry conditions are highly statistically significant in explaining firm profitability. Findings mostly diverge regarding the relative importance of industry, corporate and business-unit variables. Early work, e.g., by (Harrigan 1988c), suggested that industry traits may be more important in explaining the occurrence of alliances and their potential for value creation than firm or transaction characteristics.

Industrial economics arguments have also formed the backbone of corporate strategy [cf. (Porter 1981)]. In traditional, market-oriented strategy, the objective of the firm is to generate economic rents similar to those under conditions of non-perfect competition. Identifying and competing in markets that allow such excess profits thus is one of the foremost concerns of any corporate venture. Similarly, improving competitiveness within these markets (i.e., vis-à-vis existing or potential market rivals) allows earning above-average profits.

Reasoning 1:	Alliances create firm value by reducing competitive price pressure on a firm together with or at the expense of its competitors.

In support of the market-based perspective, survey-based empirical research has underscored the relevance of industry structure and market access as motives for cooperative arrangements [e.g., (Contractor and Lorange 1988a)]. In particular, (Glaister/Buckley 1996) identify market power and market development (i.e., entering a new and attractive markets or industries) as two distinct reasons for allying. Furthermore, they document improving competitiveness and strategic positioning as alliance motives.[47]

This section proceeds to address the specific mechanisms for firms to gain protection from competitive price pressure through collaboration: Market power (as well as alternative) rationales proposed by industrial economics and corporate strategy arguments, such as market entry and gaining competitive advantages.

2.2.1.2 Industrial Economics: Market Power Versus R&D Efficiency

Industrial economists have suggested two primary ways of how cooperative arrangements may affect industry competition, which imply diametrically different effects on overall welfare[48]. On one hand, alliances may

[47] Another rationale raised by (Glaister/Buckley 1996) is technology development. However, this is akin to entering technologically new markets and will thus be treated as part of the market entry motive. Furthermore, the authors' factor analysis identifies resource specialization and large projects, both of which refer to 'positioning alliances' discussed below. (Boateng and Glaister 2003) provide similar evidence for international JVs.

[48] Note that, in accordance with section 1.3.3, welfare is here used in its original sense, i.e., to indicate the overall benefit of a transaction scheme regardless of

generate market power. Specifically, they may reduce competition among incumbents and/or with regard to potential market entrants. On the other hand, cooperative agreements may improve efficiency in R&D by preventing inefficient investment behavior. In particular, they may compensate for insufficient incentives or help avoiding duplication of expenditures.

Market Power

Prior research has linked horizontal alliances to collusion and market power. For instance, collaboration in research and development (R&D) or production between horizontally related partners may result in reduced inter-firm rivalry and thus above market-clearing prices at the expense of customers.[49] In this case, the efficient upstream collaboration may serve as means to maintaining the downstream collusion, since the mutual benefits arising from joint R&D or production reduce the incentive for firms to defect, i.e., to compete by lowering prices in the downstream market.[50] While this would imply that R&D and production alliances may be flawed from a welfare point-of-view, newer theoretical work suggests otherwise. (Cabral 2000) shows that even when cooperating firms could collude in the short term, they may have an incentive not to, if the returns from successful innovations are sufficiently high. Similarly, (Morasch 2000) argues that alliances may in fact strengthen market competition as long as the number of alliance members remains small relative to the overall market.[51] These theoretical arguments provide reason to believe that alliances may be used as an instrument to create market power in relatively concentrated industries, but do not have to be universally anticompetitive.

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the particular recipient. More formally, it comprises the sum of producer and consumer rents [see (Tirole 1988), among others].

49 For general arguments relating to the anticompetitive effects of upstream collaboration, cf. (Katz 1986), and (D'Aspremont and Jacquemin 1988), among others.

50 Cf. Martin (1995), building upon the general argument by (Bernheim and Whinston 1990) of firms encountering each other in multiple markets. Also, any collusion represents a reduction in strategic (in this case competitive) uncertainty from an individual firm perspective [cf. (Burgers et al. 1993)].

51 Specifically, (Morasch 2000) and argues that cartel-like alliances will only persist if the number of firms in the industry is limited to 3 to 5 firms (depending on the type of market competition). Otherwise, subgroups of firms may have sufficient incentive to defect. Prior work [e.g., (Salant et al. 1983) and (Shaffer 1995)] also suggested price-setting cartels may only be stable and anticompetitive, if a fairly large share of market participants is involved. However, the size of stable cartels may vary [e.g., (D'Aspremont et al. 1983)].

In support of the market power argument, (Hagedoorn 1993) points to market restructuring as being a dominant motive of alliance formation, especially in mature and oligopolized industries. Similarly, (Glaister/Buckley 1996) identify market power as an alliance motivation pursued mostly by larger firms. (Sakakibara 2002) concurs, showing that the number of firms in a given industry negatively is related to the formation of R&D consortia. More generally, horizontal alliance activity has been empirically linked to industry concentration [(Pfeffer and Nowak 1976); (Hernán et al. 2003)], firm size [(Berg and Friedman 1981)], and market share [(Hernán et al. 2003)].[52] These findings indicate that firms controlling a reasonably large share of the product market tend to collaborate more frequently, possibly with the intention to cooperate rather than compete with direct rivals.

Early work regarding the performance impact of horizontal alliances studied the effect of joint venture activity on average industry rates of return. (Duncan 1982) documents significantly higher profitability in industries, where horizontal joint ventures are prevalent. This supports the evidence presented by (Berg and Friedman 1981) and (Berg et al. 1982) of non-knowledge acquiring joint ventures being associated with higher industry rates of return.[53] Since these studies focus on overall industry performance, they reflect collective gains due to either collusion or joint efficiency gains.

As a bottom line, anticompetitive behavior may be an explanation for the use and benefits of collaborative ventures:

Proposition 1.1:	Alliances create firm value by increasing market power, especially in quite concentrated industries.

52 These findings are also consistent with (Link and Bauer 1987) but contradictory to (Eisenhardt and Schoonhoven 1996). See (Kogut 1988b) for a review of earlier findings on horizontal alliance formation. (Pfeffer and Nowak 1976) and (Burgers et al. 1993) found the deviation of industry concentration (firm size) from the median across various industries (industry mean) negatively related to collaboration among competitors. Anticompetitive alliance benefits thus may not be monotonically related to industry concentration and firm size. The latter is also consistent with (Röller et al. 1998), who find that size symmetry among partners enhances the probability of two firms forming a research joint venture.

53 Contrarily, non-horizontal JVs [(Duncan 1982)] and knowledge-related JVs [(Berg and Friedman 1981), (Berg et al. 1982)] are associated with lower industry profitability. This reflects the short-term effects of adapting to technological change (knowledge acquisition hypothesis). (Duncan 1982) highlights the fact that the large firms composing his and the (Berg and Friedman 1981) sample mostly are knowledge acquirers rather than providers.

R&D Efficiency

While collusion and entry deterrence may increase firm value at the expense of consumers or other market participants, IO literature also suggests some efficiency-enhancing alliance effects. Specifically, collaboration may help firms overcome inefficiency arising from suboptimal incentives for research and development (R&D). Depending on the given competitive context, firms may tend to over- or underinvest in R&D, both of which reduce welfare.

Overinvestment occurs, when firms in a highly competitive setting stand to gain from proprietary innovations, such as patents or market standards. This generates incentives for firms to heavily invest in competitive R&D projects (patent races).[54] While advantageous for the eventual 'winner', this duplication of investments is inefficient from a welfare perspective. Strategic alliances may help overcome this inefficiency inherent in competitive standard setting by homogenizing investment incentives [cf. (MacMillan and Farmer 1979), (Doz and Hamel 1988), (David and Greenstein 1990)]. While the formation and stability of standard-setting alliances are hindered by the competitive rivalry among alliance participants,[55] collaborative R&D may help avoid at least some duplicate R&D spending.

Underinvestment problems may arise, when R&D has at least some public goods properties, i.e., the use of R&D results by one firm does not exclude other firms [cf. (Grossman and Shapiro 1986)]. If R&D output is not fully appropriable by the researching firm, others (including its rivals) may profit from knowledge spillovers. While such externalities are efficient from a welfare perspective, they reduce the incentives for conducting R&D and firms will choose lower levels of R&D expenditures than would be socially desirable. Collaborative R&D can restrain these incentive problems by internalizing these externalities, provided that it involves firms otherwise profiting from the spillovers [cf. (Katz 1986); (D'Aspremont and Jacquemin 1988), among others].[56] In support of the spillover internalization hypothe-

54 For instance, (Anderson and Tushman 1990) provide a model of discontinuous technological change, in which firms compete to establish a "dominant design", which will later undergo only incremental changes until another discontinuity arises. They show the selection process leading to the establishment of a dominant design standard to be highly competitive. The general concept of dominant designs goes back to (Abernathy and Utterback 1978).

55 In this context, (Axelrod et al. 1995) show multiple coalitions forming based on firm size and intensity of competition among firms, i.e., incompatible, substitutive technologies and overlapping target groups.

56 Katz (1986) argues that internalization through collaboration may even be more efficient than patent protection. Extensive patent and copyright protec-

sis, (Hernán et al. 2003) find the time lag of involuntary knowledge dissemination and the effectiveness of patent protection to reduce the rate of research joint venture formation. Both factors reflect the appropriability of research outcomes. Similarly, (Sakakibara 2002)documents higher frequency of R&D consortia formation for firms in industries with low appropriability of research findings (patent-based measure).[57]

All in all, collaborative R&D may contribute to welfare-maximization by realigning R&D incentives, when individual R&D decisions would lead to over-/underinvestment problems. These benefits also translate to the individual firm level:

Proposition 1.2:	Alliances create firm value by rectifying R&D incentives in situations of competitive R&D (patent races) or limited appropriability of R&D results (spillovers).

The industrial economics literature has focused on market power and efficient investment rationales of collaboration. Both aspects are associated with value creation at the individual firm level, although collusion and entry deterrence merely represent a transfer of wealth from consumers and other market participants. Furthermore, the vast majority of these arguments relate to collaboration among actual or would-be competitors, i.e., to horizontal alliances.

2.2.1.3 Corporate Strategy: Industry Attractiveness and Competitive Advantage

While firmly rooted in industrial economics, corporate strategy has expanded its narrow focus on industry structure to include other aspects of industry attractiveness.[58] Essentially, firms may create value by competing

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tion – while providing similar R&D incentives – would have two adverse effects on public welfare: On the one hand, firms will compete for innovations, i.e., incur duplicate R&D investments. On the other hand, the product market (following successful R&D) will be monopolized for the duration of patent protection. As a third alternative, government subsidies for R&D activities would also induce additional incentives, but are subject to extensive information asymmetries [cf. (Cassiman 2000)].

57 (Lazzarini 2003) shows that alliances may also be used to internalize other types of externalities, e.g., traffic flow (i.e., connection flights) in the global airline industry, and documents a positive influence of spillover internalization (i.e., traffic flow among cooperation partners) on firm performance.

58 The best known concept for assessing the profit potential of a given industry is the Five-Forces-Model proposed by (Porter 1980). In brief, it argues that profit generation is based on intra-industry competition, the threats of new

in favorable markets, i.e., industries in which competitors, substitutes, and powerful transaction partners are unable to keep firms from appropriating quasi-rents. Additionally, firms may realize excess profits by developing distinct advantages vis-à-vis their competitors.[59] Alliances may target the sources of such competitive advantages and allow collaborators to outperforming other firms. The present section addresses both strategic benefits of collaborative ventures.

Market-Entry Alliances

Market entry is an important alliance motive in both domestic and international settings. For instance, (Glaister/Buckley 1996) demonstrate that firms collaboratively pursue the establishment of a new market presence, faster market entry, and the internationalization of market scope. In particular, alliances may help partners overcome barriers to entry and gain access to otherwise protected markets.[60] Market-entry alliances allow firms to realize economic rents as long as potential competitors remain obstructed by these hurdles. In the following, technological and commercial entry barriers as well as specific barriers to international market entry will be discussed.

- Firms may cooperate to enter into technologically new markets or markets that would be outside of their individual technological competency.

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market entrants and substitute products as well as the relative bargaining power of buyers and suppliers. All these factors are potentially capable of forcing profit levels down to the perfect competition level. The individual forces are briefly described in Table 37 of the appendix.

These competitive forces may be regarded as deterministic in the sense that management would be restricted to selecting the industries in which to compete and conduct day-to-day operations according to by standard practices. More realistically, they provide the background, against which firms compete. Consequently, market attractiveness itself will not be further addressed in favor of focusing on its strategic implications.

59 (Schendel and Hofer 1979) distinguish between ‘where to compete’ and ‘how to compete’ as the two main dimensions of corporate strategic positioning, referring to (selective) market entry and the subsequent choice of strategic posture.

60 See (Caves and Porter 1977) for a general comment on the concept of barriers to entry. Similarly, incumbents may collaborate to erect entry barriers and remain protected from further entry. Along those lines, (Kogut 1988a) argues that alliances may deprive competitors of access to rare resources or established distribution channels (i.e., erect barriers to further entry) in addition to reducing the competitive pressure exerted by suppliers and customers.

Empirical evidence generally supports this notion.[61] For instance, (Hagedoorn 1993) shows that technological complementarity is the single most important alliance motive. With regard to performance, (Stuart 2000) observes a significant impact of technology-related alliances on sales growth. (Rothaermel 2001) documents a positive, but marginally decreasing (inverse u-shaped) relationship between alliance activity and new product development. This may reflect limitations to leveraging internal capabilities through collaboration.[62] Similarly technological product complexity may affect the benefits of alliance activity. In particular, (Singh 1997) shows technology alliances concerning medium-complexity products associated with increased firm survival whereas the effect is insignificant for highly or less complex products. Alliances may thus be best suited to situations, where the need for technological innovation exceeds internal capabilities but remains manageable by the alliance partners.

- Alliances may help firms compile the commercial capabilities necessary to successfully compete in new markets.[63] Empirically, (Baum et al. 2000) observe a significantly positive impact of marketing alliances on the growth of biotechnology start-ups. (George et al. 2001) also show that vertical alliances improve the market performance of biotechnology firms.[64] More specifically, (Mosakowski 1991) documents a significant

61 See (Schmitz Whipple and Gentry 2000) for a more comprehensive review of prior work addressing (among others) complementary partner competencies and market access.

62 Additionally, (Nicholls-Nixon and Woo 2003) point out that combinations of different types of alliances may be required for overcoming barriers to entry. In particular, they identify the number of different alliance types used as the best predictor of biotechnology products (i.e., successful new product development).
Corporate acquisitions may also be used for this purpose. Contrarily, R&D contracts and licenses are related to reputation, but not tangible research output. Joint ventures and equity alliances are not significantly related to any output measure and may thus be used for purposes of basic research or monitoring technological developments [cf. (Arora and Gambarella 1990)].

63 Early research has stressed standard barriers to entry, such as economies of scale/scope, capital requirements, and high fixed costs [e.g., (Contractor and Lorange 1988a)]. For instance, (Sharma 1998) shows the selling and distribution intensity (as share of total cost) of an industry negatively related to the persistence of independent (de novo) entrants.

64 Conversely, horizontal alliances do not exhibits such a positive influence and alliances generating or attracting technological competencies even are associated with negative market performance effects.

positive effect of sales-oriented alliance contracts on the performance of IT firms, if they concurrently pursue internal R&D.[65] This suggests that the main benefit of such alliances may arise from translating technological know-how into commercial products.

- Alliances may facilitate international market entry and help firms overcome a lack of market knowledge, cultural dissimilarities, or legal restrictions. In the survey studies by (Glaister/Buckley 1996) and (Boateng and Glaister 2003), market entry and international expansion are leading motive in the formation of international alliances and joint ventures. (Shan 1990) finds high-technology firms more likely to choose cooperative commercialization strategies in international than domestic market entries. Various studies, including (Moon 1999) and (Desai et al. 2002), demonstrate a strong positive relationship between ownership restrictive host-country regulation on foreign equity ownership and collaborative market entry.

The preceding evidence points towards alliances helping firms overcome technological, commercial, and international barriers to entry.

Proposition 1.3:	Alliances create firm value by allowing entry into markets protected from full-scale competition, which would not be accessible in isolation.

The above arguments for market-entry alliances have focused on markets already being protected from full-scale competition. Additionally, market entry itself may allow entrants to gain competitive advantage and thus reduce price pressure at least for some period of time. Collaboration may lead to first-mover advantages, if it allows entering and penetrating markets more quickly than in isolation.[66] In addition, the time required for setting up operations in a (geographically or technologically) new market reduces the benefits of market entry. In particular, ongoing competitive and technological advances render it imperative to quickly market a product of-

65 This finding is particularly noteworthy since the author documents significantly negative effects of R&D and service contracts on firm performance (measured by sales and net income). Moreover, both of these alliance types have negative interaction effects with internal R&D spending.

66 Specifically, early entrants may profit from a continuing technological leadership, preferential access to required assets (e.g., distribution channels), and switching costs incurred by customers. Conversely, possible first-mover disadvantages include freeriding on pioneer investments, the resolution of technological uncertainty, shifting customer preferences and incumbent inertia. For a more detailed treatment of first mover advantages, see (Lieberman and Montgomery 1988).

fering not only to gain first-mover advantages but also to avoid newly won capabilities becoming obsolete before they have yielded a sufficiently high return on investment. (Ohmae 1989) conceptualizes both issues for international cooperative arrangements; (Shan 1990) highlights the relevance of shortening technology life-cycles.

In support of collaborative first mover advantages, (Sarkar et al. 2001) observe alliance proactiveness having a positive effect on market performance.[67] Similarly, (Hagedoorn 1993) and (Glaister/Buckley 1996) find that a reduction in innovation time span and time-to-market is one of the most important alliance motives of both technology and internationalization alliances, respectively. Together these findings suggest that the speed of collaborative market entry may be a competitive advantage in itself.

Proposition 1.4:	Alliances create firm value by enabling first mover advantages through accelerated market entry.

Competitive Advantage Alliances

While the above arguments relate to market entry, alliances may also serve an important role as a strategic measure for intra-industry competition. In this regard, (Porter 1985) proposes three generic strategies for outperforming competitors: Cost leadership, product differentiation, and niche positioning:[68]

- Prior research has outlines a number of potential cost-reduction mechanisms: (A) Production cost rationalization may be achieved by producing at the (ex ante) lowest cost location or purchasing from the (ex ante) lowest cost source available to any one alliance partner [(Contractor and Lorange 1988a)]. (B) The chosen production regime may allow to further reduce costs by more narrowly specializing on certain products and thus quickly realizing experience curve effects [(Eccles 1981)]. Similar

[67] While proactive alliance formation increases corporate performance, this is quite distinct from entrepreneurial proactiveness in general. In fact, (Dickinson and Weaver 1997) find entrepreneurial management orientation reducing firms' allying propensity in otherwise conductive settings (i.e., uncertain environments). Entrepreneurial orientation thus may reflect individualist predispositions, whereas collectivist management culture increases the preference for cooperation for given levels of external inducements and entrepreneurial orientation.

[68] Table 38 of the appendix provides a summary of the three competitive strategies. Note that cost reduction, product differentiation, and niche positioning may be achieved through both horizontal and vertical alliances. Consequently, such these benefits may be additive to to market power and entry considerations.

cost reduction effects based on economies of scale may be realized through pooling of production [(Contractor and Lorange 1988a)]. (C) Economies of scope may reduce overall cost (Teece 1980)], e.g., by spreading fixed costs across a greater number of different products. The latter may be particularly relevant for fixed-cost intensive functions such as distribution networks [(Ohmae 1989), (Contractor and Lorange 1988a)]. (D) Quality improvements achieved through close buyer-supplier collaboration may reduce scrap rates, i.e., items having to be replaced [(Schmitz Whipple and Gentry 2000)], and lower total value-chain costs [(Dyer and Singh 1998)]. Empirically, cost reduction is an important alliance motive [cf. (Contractor and Lorange 1988a), (Schmitz Whipple and Gentry 2000)].

- Many of the above arguments on market entry also extend to product differentiation. Other examples of collaborative product differentiation strategies include co-advertising/co-branding, which aims at transferring reputation effects among partners [e.g., (Washburn et al. 2000)]. In this context, (Harrigan 1988c) shows that joint ventures between vertically related parents are rated as more successful than those between unrelated parents.[69] Vertical alliances may secure access to distribution channels (downstream) or essential resources (upstream), setting a firm apart from its competition. As (Schmitz Whipple and Gentry 2000) point out differences in alliance motivation between upstream and downstream alliances. While upstream alliances are entered mostly for reducing inventories and stabilizing supply (i.e., cost reduction), downstream alliances focus on gaining customer loyalty and involvement [e.g., (Magrath and Hardy 1994)].
- Alliances may provide firms with cost or differentiation advantages in niche markets. More specifically, collaboration may be required to develop a product offering specifically adjusted for the target segment or adapting existing (mass-market) products may be more cost-efficient than developing niche product from scratch. In this context, (Harrigan 1988a) argues that firms may enter into a multitude of different alliances (spider-web approach) in order to accommodate settings not allowing for product standardization across sub-markets. Alliances may thus be a core strategic tool for firms pursuing positioning in multiple niche markets.

In all, alliances thus may allow firms to successfully compete based on relative cost advantages, product differentiation, and/or niche positioning.

[69] The positive effect of relatedness shown by (Harrigan 1988c) appears to be even stronger for horizontal constellations. At the same time, this effect may be attributable primarily to collusion or cost reduction as pointed out earlier.

Proposition 1.5:	Alliances create firm value by generating strategic cost and/or differentiation advantages vis-à-vis competitors in existing markets.

2.2.2 Resource-Based and Learning Theories of Collaboration

The resource-based view of the firm (RBV) takes an inside-out perspective as opposed to the outside-in view of traditional market-based strategy. While the latter implicitly assumed firms to be homogeneous, the RBV explicitly addresses the firm-specific sources of performance variation [cf. (Barney 1991); (Das and Teng 2000b)].[70]

2.2.2.1 The Resource-Based View of Corporate Cooperation

On a general level, the RBV argues that competitive advantages arise out of the individual firms' resource endowments [see e.g., (Wernerfelt 1984), (Barney 1991)]. Since no two firms possess identical resource bases, they employ different strategies and experience different levels of performance. As (Barney 1991) argues, neither first mover advantages nor entry barriers can exist without these two prerequisites.

For resources to yield sustainable competitive advantages and above-average performance, they need to be persistently heterogeneous and relevant from a competitive perspective. In particular, strategic resources are required to possess five key attributes: (1) value, (2) rarity, (3) imperfect mobility, (4) imperfect imitability, and (5) imperfect substitutability. [cf. (Barney 1991), (Peteraf 1993)].[71] Resources must be valuable and rare but neither (perfectly) mobile, (perfectly) imitable nor (perfectly) substitutable

70 In spite of these fundamental differences, the RBV builds on some industrial organization concepts. In particular, (Conner 1991) observes congruence ranging from merely agreeing on the firm being an input-combiner (neoclassical IO) to shared concepts of asset specificity and small numbers bargaining (transaction cost economics). While these different approaches thus draw on similar conceptual foundations, the present thesis focuses on their substantially different applications in collaborative contexts.

71 The former two aspects determine the relevance of resources for competition. However, competitive advantages resulting from rare, valuable resources cannot be appropriated and sustained if firms not initially possessing such resources find other ways of duplicating strategies. See Table 39 of the appendix for further descriptions of the five conditions.

in order to be considered sources of competitive advantage.[72] Such valuable resources may be the focus of collaborative ventures. In particular, they (a) directly affect alliance formation and (b) themselves are affected by alliance activity and (c) may influence the performance implications of strategic alliances.

- With regard to alliance formation (a), the involved firms' ex ante resource endowments and needs affect their propensity to collaborate. In this context, (Eisenhardt and Schoonhoven 1996) and (Ahuja 2000b) raise the distinction of inducements and opportunities for cooperating. Plainly stated, a company allies in order to compensate for own shortcomings, whereas its counterpart requires it to already possess resources making it an attractive partner. Thus, the possession of certain resources and the lack of other resources are prerequisites for cooperation. As (Eisenhardt and Schoonhoven 1996) put it, "firms must have resources to get resources" (p. 137).
- In addition, strategic resources may both result from inter-firm collaboration (b) and affect alliance performance (c). (Kogut 1988b) and (Das and Teng 2000b) identify two resource-based objectives for corporate collaboration: obtaining or accessing other firms' resources and maximizing the value of one's own resources. Similarly, (Dyer and Singh 1998) point out that the combination of two firms' resources only increases firm value if the resources themselves become more valuable or if the cooperation leads to the creation of new valuable resources. Both partners' resource endowments thus are relevant sources of collaborative benefits.

Consequently, resource complementarity plays an essential role in alliance formation, further resource creation, and alliance performance:

Reasoning 2:	Collaborative value creation is based on complementary strategic resources, which foster alliance formation, joint development of additional resources, and alliance performance.

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72 Additionally, limited mobility of strategic resources, social complexity, and causal ambiguity may prevent standard arm's-length market transactions, such as the sale of valuable resources [cf. (Eisenhardt and Schoonhoven 1996)]. Therefore, the resource-based rationale provides a first indication why alliances are may be superior to other transaction mechanisms. This issue will be further elaborated in the following subchapter (2.3) relying on the transaction-cost approach (section 2.3.1).

2.2.2.2 Technological and Commercial Resources

Distinct types of corporate resources may differently affect the likelihood of collaborative ventures and their performance impact. In this context, various typologies of corporate resources exist [see (Das and Teng 2000b) for an overview], including the distinctions between tangible and intangible resources [(Grant 1991)], between property-based and knowledge-based resources [(Miller and Shamsie 1996)], as well as between physical capital, human capital, and organizational resources [(Barney 1991)]. In empirical research, a threefold resource classification has gained greatest prominence, distinguishing technical, commercial, and social capital [e.g., (Shan et al. 1994), (Ahuja 2000b)]. The present study follows this precedent.[73]

Technological Resources
Technical[74] capital primarily reflects a firm's ability to innovate.[75] Prior research has addressed the influence of technological capital on alliance formation, the collaborative creation of technological resources, and their performance effects.

A firm's technological resources are fundamental to alliance formation decisions, with regard to both collaborative opportunities and inducements. On the most basic level, (Sakakibara 2002) detects a significantly positive influence of firms' R&D capabilities on their participation in R&D consortia. Similarly, (Ahuja 2000b) and (Kelley and Rice 2002) find technical

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73 Note that the terms firm resources and capital are used interchangably in the present study. Specifically, capital refers to a firm's entire (i.e., tangible and intagible) resources of a given type. For instance, technological resources include both tangible technologies (e.g., patents) and intangible technological knowledge.

74 In the present work, the terms technical capital and technological resources are used synonymously. Technically, however, the terms diverge in that technological not only applies to concrete (i.e., technical) knowledge regarding one particular problem, but represents a broader class of (technological) knowledge applicable to an entire class of problems [cf. (Teece 1977), (Von Hippel 1988)]. As (Brockhoff and Chakrabarti 1988) point out, technological knowledge also extends to the knowledge of applying technical resources.

75 Given the difficulty of empirically measuring intangible resources, prior research has predominantly used tangible proxies, such as patents, financial means, or prior alliances. This caveat of empirical evidence may be less of a concern in event-study research, since it appropriately reflects the market's factual knowledge of firm resources. Table 40 of the appendix provides an overview of measures used to approximate techological (as well as commercial and social) resources.

capital to significantly increase the number of technical alliances formed. This evidence is consistent across various patent-based indicators of technological capabilities, including the mere existence of patent portfolios, the total number of patents held, and citation-based measures of patent quality. (Ahuja 2000b) particularly highlights the relevance of important innovations and key patents, which may represent particularly valuable technological breakthroughs. Such 'drastic' innovations have an additional significantly positive impact on alliance formation. Similarly, (Eisenhardt and Schoonhoven 1996) show technological leaders pursuing innovative technology strategies having higher rates of alliance formation. All these findings point towards technological capital creating opportunities for collaboration.

Conversely, the inducements to collaborate are lower for technologically advanced firms. Along those lines, (Shan 1990) observes a reduced propensity to choose alliances over proprietary commercialization for firms in technological leadership positions. Similarly, (Park et al. 2002) and (Oliver 2001) find a significantly negative effect of technological resource diversity on alliance formation indicating that firms endowed with sufficiently diverse internal resource do not have sufficient incentive for entering into technology-related alliances.[76] On the opposite side of the spectrum, (Oxley and Sampson 2004) complementary find that followers cooperate on a broader scale than technological leaders, in particular more likely including joint manufacturing and/or marketing activities.[77] As a whole, this evidence suggests that the prior technological capabilities reduce the incentive to collaborate.

Once alliances are operational, they may improve firm innovativeness, i.e., further technological resources creation. For instance, (Baum et al. 2000)] and (George et al. 2002) show that biotechnology firms may expand their patent portfolios through collaborative links.[78] Among others,

[76] Complementarily, (Oliver 2001) observes the breadth of firms' product portfolios to significantly increase their alliance formation rates.

[77] In an international context, (Hitt et al. 2000) find that firms from emerging markets consider technical capabilities (as well as intangible assets and quality capability) significantly more strongly in choosing an alliance partner than established-market firms. This finding is in contrast to complementary capabilities in general, which are similarly important in established and in emerging markets.

[78] While these findings apply to all types of collaboration, specific benefits may differ with partner and transaction characteristics. For instance, (George et al. 2002) observe that alliances with university (but not other firms) reduce the level of R&D spending required for achieving given technological advances. Similarly, (Nicholls-Nixon and Woo 2003), find contract-based alliances and

(Stuart 2000) and (Sampson 2002), stress the importance of resource complementarity and find that both partnering firms' patent bases combine to significantly increase biotechnology firms' innovation output. More generally, (Mothe and Quelin 2001) find that complementary assets between alliance partners lead to increased new product development (NPD) and intangible knowledge accumulation.

Finally, the generally positive effect of technology-related alliance activity on firm performance (see subsection 2.2.1.3 above) varies with the partner firms' technological resource endowments. For instance, Stuart (2000) demonstrates a significantly positive impact of alliance partners' innovativeness (i.e., number of patents) on the sales growth experienced by cooperating firms. Access to partner firms' technological resources thus may be a substantial performance driver. (Hagedoorn and Schakenraad 1994) show alliances attracting other firms' resources as yielding higher profits than alliances targeting joint resource development. Furthermore, the quality of a resource base increases the collaborative benefits for alliance partners. Along those lines, (Coombs and Deeds 2000) show that the compensation biotechnology firms receive as part of alliance agreements is related to their technical capital.[79]

As bottom-line, focal firms' technological resources appear to determine alliance formation decisions, whereas partner resources form the basis for collaborative performance effects. The creation of additional technological capabilities is most strongly related to resource complementarity.

Proposition 2.1:	Collaborative value creation is linked to the extent and complementarity of technological resources.

Commercial Resources

The second type of resources, commercial capital, encompasses financial means, production and marketing capabilities, all of which are necessary to

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licensing agreements positively associated with technological reputation, although they find no effect on actual patents.

79 Among various potential indicators, however, only the number of patents owned and the number of development projects in advances (phase III) clinical trials were found to be significant. The latter suggests that the value of technical capital is specifically assessed by the alliance partner, especially if cooperative agreements entail substantial financial commitments. While earlier stage R&D projects may be similarly promising, their uncertainty reduces the expected value for an external 'investor'. Also see subsection 2.3.2.1 on this notion from an organizational economics perspective.

generate revenue from technological innovations.[80] The ownership of such complementary assets may allow companies to enter into alliances and thereby appropriate a share of the innovations' value [cf. (Teece 1986)]. Similar to the case of technological resources, commercial capital may exert an influence on the formation of collaborative arrangements as well as on firm performance, while at the same time being affected by alliance activity.

Internal commercial capabilities are related to the formation of strategic alliances. In fact, (Ahuja 2000b) identifies commercial capital considerations as having the most direct impact relative to both technical and social capital. Specifically, he shows that firms' commercial capital (proxied by their book value of assets) significantly positively influences the number of technical linkages formed. (Park et al. 2002) also find that financial resources (measured as the total capital funding acquired by the start-up firms studied) increase alliance formation. (Eisenhardt and Schoonhoven 1996) document a significant positive effect of firm age on alliance formation rates. Similarly, (Shan et al. 1994) and (Oliver 2001) show that publicly traded firms have a significantly larger number of inter-firm ties.[81] All of these findings indicate that the possession of commercial capital may be a necessary condition for alliance formation.

While firms rich in commercial capital thus may be attractive alliance partners, they may also be more capable of achieving market success without cooperation. In particular, the complementarity of different commercial assets may better explain alliance formation than each firm's individual resource base. (Chung et al. 2000) show that differences in investment banks' industry and market specialization significantly influence alliance formation. Along the same lines, (Hitt et al. 2000) identify unique competencies and domestic market knowledge as factors attracting international cooperation partners to firms in emerging markets. (Ahuja 2000b) extends this logic to complementarities between technological and commercial capital, finding the interaction of both resource types significantly reducing the likelihood of alliance formation. More generally, (Combs and Ketchen

[80] While commercial capital thus encompasses a wide variety of resources (including truly intangible ones, such as management skills), measurability issues have limited prior empirical investigation to tangible assets. As illustrated in Table 40 of the appendix, firm size has been the predominant proxy of commercial capital.

[81] Contrarily, (Shan 1990) finds that firm size (measured as number of employees) is negatively associated with cooperative activity. In this context, firm size, public listing, and firm age may approximate both internal resources and public awareness.

1999a) argue that firms with sufficient internal technical capital will only enter into alliances if they lack sufficient commercial capabilities internally (and vice versa).[82] Overall, prior commercial resource endowments thus reduce collaborative incentives.

Access to external commercial resources may allow firms to expand their internal resource bases. For instance, (Shan et al. 1994) find that commercial ties are positively related with a firm's innovation output (i.e., number of patents).[83] Similarly, (Ahuja 2000b) documents a significant positive influence of marketing collaboration have a on the likelihood of technical alliance formation. These findings suggest that firms may raise the commercial (especially financial) resources required for internal R&D through collaboration. Furthermore, alliances may enable a direct transfer of commercial capabilities between collaborators. In particular, (Uzzi and Gillespie 2002) show that multiple long-standing bank relationships allow firms to improve internal commercial capabilities, such as trade credit management.

Finally, commercial capital may affect the performance implications of collaborative agreements. Similar to the case of technological capital, access to partner firm commercial resources may be fundamental to collaborative performance effects. For instance, Stuart (2000) finds that partner sales have a significantly positive impact on the sales growth experienced by small high-technology firms.[84] At the same time, the complementary resource contributions may further raise performance. Generally, (Pearce and Hatfield 2002) show that (manufacturing) JVs best achieve their goals, when both partners equitably contribute resources to the venture. In a study

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82 (Combs and Ketchen 1999b) find that firms lacking financial capital and brand name reputation engage in significantly more strategic alliances than firms already possessing such resources. More recently, (Combs and Ketchen 2003) provide meta-analytic evidence on the importance of commerical resource considerations on the choice of franchising as an entrepreneurial business model.
Additionally, (Ahuja 2000b) shows that capital-poor firms, i.e., below the sample median in technical, commercial, and social capital, may compensate for this deficiency, if they have achieved important technological breakthroughs over the preceding two to four years.

83 In theory, this evidence may be subject to an endogeneity bias (i.e., expected innovation output leading to commercial ties). However, (Shan et al. 1994) find no significant effect of patents on commercial ties.

84 In survey-based research, (Saxton 1997) highlights the significantly positive effects of partner firm's reputation for management and product quality on perceived alliance performance and satisfaction. This indicates that the relevant partner resources need not be financial or even tangible.

of Israeli high-technology firms, (Yeheskel et al. 2001) observe that production alliances with local partners and marketing alliances with international partners exhibit the best performance.

In brief, focal firms' commercial resource endowments affect opportunities and inducements to collaborate. Partner firm resources (and their complementarity) form the basis of further resource creation and collaborative performance.

Proposition 2.2:	Collaborative value creation is linked to focal firms' commercial capital, which facilitates alliance formation, and the complementarity of partner resources (including technological capital).

2.2.2.3 Social Capital and Alliance Networks

Social capital represents a company's prior external links and its embeddedness in relevant networks. Similar to other strategic resources, the goodwill associated with social capital may create both facilitative and substantive benefits [cf. (Ahuja 2000a)]. As a facilitator, social capital enables further inter-firm collaboration, which in return derives its substantive benefits from technological or commercial resources. This is may be due to the higher visibility of well-linked firms or to their greater awareness of alliance opportunities.[85] Substantively, social capital may be a value-creating asset in itself. For instance, network participation may allow firms to profit from knowledge spillovers and commercial opportunities arising within the network. Prior research has addressed three types of social resources: Personal, organizational, and network-embedded social capital.

Personal social capital refers to relations between individuals in different organizations. (Eisenhardt and Schoonhoven 1996) document a significant effect of management team characteristics facilitating alliance formation. Specifically, they observe that the rate of alliance formation is positively associated with management team size (number of executives), industry experience (number of previous employers), and seniority (mean previous job title). These findings suggest that executives' specific experience may allow them to develop social capital, facilitating alliance formation. Substantively, (Luo 2001) shows that personal relations between alliance partners improve alliance operations and firm performance. In

85 Note that this is distinct from the greater level of trustworthiness attributed well-connect firms by potential partners, which essentially reflects reduced information asymmetries. This notion will be further addressed in section 2.3.2.

particular, an overlap in management tenure and cultural congruity between collaborating firms yield such personal social capital effects.[86]

Proposition 2.3a:	Collaborative value creation is linked to personal social capital, which facilitates alliance formation and, at the dyadic level, improves alliance performance.

Organizational social capital represents the existing ties a firm has to environment. Among others, (Ahuja 2000b) and (Sakakibara 2002) support the hypothesized facilitative effects of network size (proxied by the number of prior collaborations) on further alliance formation. The facilitating benefits of social capital may, however, decrease if it is overused. Along those lines, (Chung et al. 2000), while generally supporting the positive effect of social capital, show that the impact of ties between two partners on alliance formation decreases for particularly active dyads.[87] Similarly, (Park et al. 2002) observe that the diversity of alliance experience rather than the mere number of prior alliances increases the likelihood of alliance formation. This evidence suggests that prior alliances may create follow-on opportunities or serve as positive signals for potential alliance partners.

Organizational social capital also substantively affects alliance performance.[88] Using biotechnology firms' geographical location as an indicator for social capital, (Coombs and Deeds 2000) find that firms in main biotechnology clusters receive higher compensation as part of alliance agreements. Since such alliances are technology-driven, substantive effect of social capital may depend on the prospects of knowledge spillovers and

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86 The observed effects are not confounded by general managerial experience effects. As such, (Combs and Ketchen 1999b) do not find management experience within the industry and with the focal firm significant in determining alliance formation or performance (ROA and market-to-book ratio). Similarly, (Coombs and Deeds 2000) observe that management's international work experience is insignificant with regard to the revenue biotechnology firms derive from international alliances.

87 In their study of the investment banking industry, (Chung et al. 2000) document significantly positive, but marginally declining effects of direct (i.e., participation of one bank in transactions led by the other) as well as indirect ties (i.e., both firms participating in a transaction led by a third institution). Similarly, a lack of reciprocity (i.e., the lead bank having offered overproportionally more transactions to the potential partner) is also associated with a lower likelihood of collaboration.

88 As the performance impact of prior or concurrent alliances may stem from their social-capital effects or better alliance-management skills, this evidence is presented in subsection 2.2.2.4 (alliance experience).

better information access.[89] Moreover, (Lee et al. 2001) find that linkages to universities, venture capitalists, venture associations/networks, and financial institutions only significantly increase the sales growth start-up firms in combination with internal financial resources, technological capabilities, and entrepreneurial orientation.[90] Firms may thus require complementary internal resources to effectively realize the substantive benefits of social capital.

Proposition 2.3b:	Collaborative value creation is linked to organizational social capital, which facilitates the formation of new linkages and provides additional substantive benefits.

The entirety of companies' direct and indirect relationships with their environment constitutes their overall network. The characteristics of these networks can affect further alliance formation and performance.[91] With regard to facilitation, (Shan et al. 1994) find that the extent of network embeddedness significantly increases the number of additional commercial ties formed. More centrally located firms thus receive additional collaborative opportunities.

Substantively, extensive networks may provide the breeding ground for technological innovation. For instance, (Ahuja 2000a) shows that the overall number of direct and indirect ties has a positive impact on patenting. Similarly, (Yao and McEvily 2001)show embeddedness to be positively associated with innovation.[92] Conversely, (Ahuja 2000a) and (Yao and McEvily 2001) find structural holes [i.e., small numbers of redundant (both direct and indirect) ties] to have a negative impact on patenting rates.

89 Conversely, (Park et al. 2002) do not document any evidence of location advantages for Silicon Valley semiconductor firms.

90 Conversely, (Lee et al. 2001) do not document any direct effects of prior linkages, except for venture capitalist funding. Additionally, linkages to other enterprises have neither significant direct nor indirect effects. As the authors note, such alliances prevalently involving other small Korean firms.

91 Actors' positions in social networks may be described along two main dimensions: First, structual centrality reflects the degree of an actor's entrenchment in a given network [cf. (Freeman 1978/79), (Friedkin 1991)]. Second, ease of information flows across the network is constitutes their efficiency [cf. (Coleman 1988)¸ (Latora and Marchiori 2001)]. While a detailed discussion of these concepts exceeds the scope of the present work [see (Latora and Marchiori 2004) for a review], Table 41 of the appendix provides a summary.

92 While these findings refer to inter-firm networks, (Tsai 2001) also finds that one business unit's access to other business units' knowledge bases (intra-firm network centrality) significantly increases its rate of new product introductions.

While networks rich in redundant ties may generate valuable knowledge spillovers,[93] their commercial benefits are inferior to those of more efficient networks (i.e., networks having a greater share of exclusive ties and structural holes). Specifically, Baum/Calabrese/Silverman (2000) show that network efficiency has a significantly positive effect on the growth of young biotechnology firms. Selective (i.e., exclusive) ties thus yield better performance effects than vast but inefficient networks.[94]

Proposition 2.3c:	Collaborative value creation is linked to the social capital of network embeddedness, which generates additional alliance opportunities and substantively affects resource development and commercial performance.

To summarize, prior research provides comprehensive evidence that social capital facilitates alliance formation and substantively improves firm performance as well as further resource creation. Differences between personal, organizational, and network-based social capital exist, but are limited. In particular, the effects of personal social capital appear to be strongest at the dyadic level, i.e., pertaining to the specific pair of firms, whereas organizational and network-based social capital apply to all focal firm alliances.

2.2.2.4 Organizational Learning in Cooperative Settings

The three types of strategic resources discussed thus far have addressed the direct benefits such assets may have in an alliance context, i.e., how they affect alliance formation and alliance performance. Organizational learning extends this perspective by also considering the processes of resource transfers and resource generation in an alliance context. While acquiring knowledge is an important function of collaborative ventures, the learning perspective also applies to the act of collaboration itself, i.e., firms may

93 (Owen-Smith and Powell 2004) distinguish between local and dispersed networks. In the local environment, being part of networks has a positive influence on innovation, whereas more diverse partners have a negative effect. This indicates greater knowledge spillovers in homogeneous local networks. Conversely, partner diversity in dispersed alliances has a positive impact on patent output, since they may allow firms to pick up new developments early.

94 This is in line with (Burt 1992), who originally interpreted structural holes as allowing firms to capitalize on opportunities within the network by brokering among unrelated participants.

learn 'how to cooperate' as well learning 'specific content' through collaboration.[95] The present subsection addresses both issues.

Collaborative Competence & Alliance Experience

Collaborating firms differ in their ability to reap collaborative benefits. For instance, (Sividas and Dwyer 2000) find that collaborative competence has a positive effect on perceived success in collaborative new product development. Similarly, (Simonin 1997) documents a significant effect of collaborative know-how increasing tangible and intangible alliance benefits. Firms develop collaborative competence based on the insights they gain in prior alliances. As such, (Simonin 1997) shows collaborative know-how to be derived from collaborative experience. (Lyle 1988) also indicates that firms learn to adapt and improve their approach to collaboration with increased JV experience. In particular, firms may gain competence in (a) identifying and selecting potential partners, (b) negotiating the terms and structure of alliances, (c) monitoring and managing ongoing alliances, and (d) terminating collaborations [cf. (Simonin 1997)].

As the best available approximation for collaborative competence, alliance experience has therefore been extensively linked to improved alliance performance. For instance, (Glaister/Buckley 1996) demonstrate that firms with multiple alliances are significantly more satisfied with their alliances. Similarly, (Powell et al. 1996) show a significant influence of experience in managing organizational ties on company growth (as well as on the formation of additional organizational links).[96] In an international context, (Barkema et al. 1997) document a significant positive effect of previous JV experience on the survival of IJVs. Similarly, (Child and Yan 2003) find IJV performance to be strongly influenced by the combined IJV experience

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95 (Inkpen 1998) identifies knowledge accessibility, knowledge connections, and effective knowledge acquisition as the prerequisites for successful interorganizational learning. For instance, firms may develop internal and intra-alliance routines to increase the effectiveness of knowledge acquisition and thus collaborative performance. See **Table 42** in the appendix for a general note on the concept of organizational learning.

96 (Powell et al. 1996) also distinguish between experience in R&D versus other collaborations. Interestingly, the former only has a significant effect on the likelihood of a firm being publicly listed (as a growth indicator), whereas the latter also increases employee growth. In the biotechnology setting studies, this reflects the overwhelming importance of technological capabilities being sufficient to 'go public' without having expanded the business-side through commercialization alliances. In their research, (Powell et al. 1996) rely on the time since the inception of the first tie as a proxy for alliance experience.

of both partners.[97] Collaborative experience (and competence) thus has a well-documented positive influence on alliance performance. However, these benefits may be subject to time- and partner-specific moderation:

First, collaborative competence may be restricted by firms' general ability to internalize and maintain organizational knowledge. With regard to new resource creation (i.e., patenting), (Sampson 2002) observes a significantly positive but marginally declining effect of collaborative experience. Additionally, the advantages of alliance experience may decay over time, as (Sampson 2002) documents a significantly increased innovation output for firms having entered their most recent alliance in the year prior to the focal alliance's formation.[98] Consequently, a steady flow of alliance activity is required to maintain collaborative capability, whereas greater numbers of alliances are not associated with additional learning of 'how to co-operate'.

Second, it is important to distinguish between general alliance skills and partner-specific routines, which require prior or ongoing interaction with the given partner. In this context, (Sampson 2002) observes distinct significant effects of both general and partner-specific experience on alliance performance. Similarly, (Harrigan 1988c), (Luo 1997), and (Child and Yan 2003) find that JV performance is positively related to the time since JV inception and the history of partner familiarity (i.e., number of years firms have previously collaborated). These findings indicate that partner-specific routines may improve collaborative performance, but require evolving.[99]

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[97] Conversely, other researchers failed to record a significant influence of prior experience on JV success [(Harrigan 1988c)] and learning in IJVs [(Inkpen 1995)]. This suggests that the effectiveness of collaborative experience may be affected by its specific context. Along those lines, both (Barkema et al. 1997) and (Child and Yan 2003) document a significant influence of prior international and host country experience on the survival and performance of IJVs, respectively.

[98] More specifically, (Sampson 2002) finds having entered alliances within the past one to three years to improve innovation performance, whereas earlier alliance experience even has a slightly (marginally significant) adverse effect. Furthermore, (Sampson 2002) shows that firms having entered 5 or more alliances over that period do not generate greater innovation output than firms having at least one prior alliance. Consequently, the internalization and decay effects appear to be complementary.

[99] Additionally, (Sampson 2003) provides evidence of these effects being most pronounced in joint venture (JV) rather than contractual alliances. As outlined in section 2.3.1, JVs are more complex and thus difficult to manage, thus increasing the need for partner-specific experience. Similarly, (Kotabe et al. 2003) observe a significant effect of link duration only for broad technology

Third, alliance experience needs to be effectively translated into improved alliance management practices, such as inter-firm communication [(Grant 1996)], information sharing [(Mohr and Spekman 1994)], and cooperative culture [(Brouthers et al. 1995)]. Along those lines, (Simonin 1997) indicates that collaborative competence may be a necessary mediator for the effect of between.[100] Concurrently, (Kale et al. 2000) find the mere existence of prior alliances between the partners insignificant when controlling for specific aspects of the inter-firm relationship. They rather show that the proactive management of conflict within an alliance is the most important determinant of successful learning alliances.[101]

Overall, the existing evidence suggests that collaborative competence is a necessary prerequisite for fully realizing collaborative benefits. It is developed over the course of alliance activity, either in general or with regard to a specific partner.

Proposition 2.4:	Collaborative value creation is linked to the collaborative competence resulting from alliance experience, which allows firms to manage alliances and collaborate more effectively.

Absorptive capacity & Learning races

The preceding discussion established the notion that firms may differently profit from collaborative learning opportunities. This may be even more prevalent with regard to technological learning, since firms start with

transfers as opposed to 'simple' technical exchanges. These more complex agreements initially have an adverse impact on supplier performance, which only turns positive once firms learn to more fully realized the benefits of collaboration.

Finally, Sampson (2002) suggests that prior alliance experience is most helpful in rather uncertain environments. This provides a first glance at the role of mutual trust, which is further discussed in section 2.3.2.

100 Specifically, all direct effects of alliance experience on tangible or intangible benefits are insignificant in the LISREL models (Simonin 1997) employs. Model specification is best for a parsimonious model without such direct effects.

101 In addition to having a significantly positive primary effect on perceived learning and protection of proprietary core assets, conflict management also significantly increases relational capital among alliance partners. Such relational goodwill in return is significantly associated with improved intra-alliance learning. Alternatively, relational capital may be rooted in partner similarity. For instance, (Lane and Lubatkin 1998) find that the similarity of lower management formalization, management centralization, research centralization, and compensation practices increases interorganizational learning.

vastly different backgrounds and capabilities.[102] Specifically, firms may differ in their abilities to (a) recognize the value of new, external information, (b) assimilate it into their knowledge base, and (c) apply it to further their commercial success. (Cohen and Levinthal 1990) devise the concept of a firm's 'absorptive capacity' (AC) to reflect these three dimensions of learning ability.[103] Similarly, the concept of 'receptivity' [(Hamel 1991)] identifies a firm's ability to absorb new skills from its partners. Both (Cohen and Levinthal 1990) and (Hamel 1991) agree that absorptive capacity (and receptivity) are dependent on a firm's prior experience in the area of focus, since only a stock of sufficiently related knowledge allows to more easily understand and learn new knowledge.

For empirical support, several studies provide evidence of absorptive capacity enabling firms to better profit from collaborative learning opportunities and thus to realize higher levels of innovation and commercial success. For instance, (Chen 2004) documents significantly better intra-alliance knowledge transfer for higher levels of absorptive capacity. Similarly, (Mothe and Quelin 2001) find an allying firm's R&D capabilities, i.e., its experience in the focal area of research, to be positively related to the creation of technological and intangible knowledge as part of the alliance. With regard to performance, (Luo 1997) finds that Chinese IJV parent firms' absorptive capacity, product relatedness, and prior international business experience all have significantly positive effects.[104] All this evi-

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[102] In addition, some technological knowledge may be difficult to transfer or access. In particular, when such knowledge is intangible and non-codifiable, i.e., tacit, it may be difficult to learn. Other sources of tacitness include resources being embedded in a specific organizational context or ambiguous in their causal function. While hindering organizational learning, these characteristics make such resources difficult to replicate inimitable, and thus valuable. For the general notion of tacit knowledge, cf. (Teece 1981).

[103] Note that the concept on absorptive capacity more generally applies to all corporate learning, i.e., also outside of strategic alliances and with regard to other types of (non-technical) knowledge. In a collaborative context, it encompasses learning preexisting partner capabilities as well as internalizing newly generated knowledge. See Table 43 and Figure 53 of the appendix for further details.

[104] Moreover, (Tsai 2001) shows absorptive capacity to reinforce the advantages business units derive from being centrally located in an network [also see FN 92]. While both absorptive capacity and network centrality have independently significant effects, new product introductions and financial performance are even further increased by their interaction.

dence points towards absorptive capacity ameliorating collaborative learning and performance.[105]

While prior knowledge in targeted technological domains thus may facilitate the assimilation of external knowledge, a too extensive overlap may reduce the scope of potential learning. In this context, both (Yao and McEvily 2001) and (Sampson 2002, 2004a) show that the technological distance between the topic of collaboration and the focal firm's main area of expertise has a significantly positive but marginally declining impact on innovation output.[106] Similarly, (Lane and Lubatkin 1998) indicate that a mutual understanding of fundamental knowledge is helpful but sufficient for successful R&D collaborations.[107] Overall, these findings suggest that some (moderate) level of technological relatedness provides an optimal combination of absorptive capacity and new 'learnable' knowledge.

Proposition 2.5:	Collaborative value creation is linked to absorptive capacity. The latter facilitates learning from collaborative contacts, as long as partner knowledge remains sufficiently dissimilar to provide room for learning.

The fact that firms differ in their ability to value, assimilate, and apply partnering firms' knowledge may lead to alliances becoming competitive with regard to collaborative success. Specifically, the speed of learning may alter the balance of power within a collaborative relationship and reduce the incentive to cooperate for a partner firm who has sufficiently sat-

105 At the same time, (George et al. 2001) provide evidence favoring a reciprocal relationship. Both indicators of absorptive capacity (R&D spending and patents) significantly increase with horizontal and attractive alliances, such as patent swap and licensing agreements. Since these alliances, however, do not have a direct effect on firm performance, their main functoin may be to position firms to profit from future learning opportunities. Such arguments are extended in subchapter 2.4.

106 Conversely, (Ahuja 2000a) observes an outright negative effect of technological distance between alliance partners on patenting rates.

107 (Lane and Lubatkin 1998) show that the number of shared research communities in general biochemistry increases learning in bio-pharmaceutical alliances, whereas specialized non-biochemical overlap even has an adverse effect on collaborative learning. As biochemistry forms the basis of all specialized area, this provides the 'common ground' for interorganizational R&D. Additionally, the interactions of both knowledge types relevance with shared research communities have significantly negative effects, indicating that absorptive capacity may be detrimental, when collaborating in own core businesses, where knowledge spillovers to the partner would substantially hurt the focal firm.

isfied its individual learning objective [cf. (Inkpen and Beamish 1997)].[108] Collaborators thus have an incentive to 'outlearn' their partners in order to reduce their dependence on partner knowledge and strengthen their bargaining power, e.g., leading to a more favorable partitioning of collaborative profits.[109] (Hamel 1991) refers to this situation as a "race to learn" (p. 85). Such learning races may result in alliance instability. As (Young and Olk 1994) and (Olk and Young 1997) empirically show, the achievement of firms' learning objectives in R&D consortia decreases their commitment and increases the likelihood of them leaving the consortium.[110]

In effect, firm heterogeneity in learning ability thus holds the danger of intra-alliance conflicts, expropriation, and alliance instability. This raises the questions why learning is pursued in alliances rather than by acquisitions or other means and how collaborators can protect themselves from expropriation risks, if alliance-based learning is chosen. The organizational economics approaches discussed in the following section address such issues.

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108 (Inkpen and Beamish 1997) deduct that alliances geared towards acquiring partners' knowledge may lead to instability, whereas cooperation based on a mutual interest in accessing complementary knowledge will be highly stable. Similarly, (Shenkar and Li 1999), addressing the knowledge sought by Chinese JV partners, find that firms mostly focus on complementary knowledge rather than searching additional (specialized) knowledge in their own core knowledge areas. This may limit the learning benefits available to collaboration partners. See (Grant and Baden-Fuller 2004) for a more thorough distinction of knowledge acquiring versus knowledge accessing alliances.

109 Similarly, (Yan and Gray 1994) suggest that relative bargaining power influences the control over management exerted by JV parents, which in return affects the achievement of parent-specific collaboration objectives. Furthermore, (Yan and Gray 1994) distinguish the determinants of bargaining power as context-based, i.e., stakes in and alternatives to the collaboration, and resource-based. More generally, the notion on organizational dependence on external resources forms the basis for the resource dependence theory [(Pfeffer and Salancik 1978)].

110 Conversely, dependence on the consortium and the importance of the joint research to the firm's primary area of research increase and induce a desire to remain part of the consortium. The magnitude of the 'satisfied learning' effect in (Young and Olk 1994) is at least as large as the positive impact of overall satisfaction with the consortium. In (Olk and Young 1997), however, the effect, while significant, is more than overcompensated by overall satisfaction and involvement/embeddedness in the consortium.

2.3 Organizational Economics of Collaboration

Market-based corporate strategy and the RBV highlight the advantages of corporate combinations, without explicitly addressing the choice of collaboration over alternative transaction schemes. That is, many strategic benefits (e.g., market power, economies of scale) could be similarly achieved by M&A and strategic resources may be acquired through arm's length transactions.

The new institutional economics (NIE) paradigm outlined by (Williamson 2000), among others, takes a complementary perspective by emphasizing the efficiency of organizational designs.[111] In the following, transaction cost economics (TCE) will serve as foundation for the trade-off between alternative transaction structures (section 2.3.1). Agency-based (and game-theoretic) considerations extend this approach by addressing the antecedents of cooperative post-formation behavior (section 2.3.2).

2.3.1 Transaction Cost Economics and Alliance Structure

2.3.1.1 Transaction Costs and Hybrid Organizations

TCE aims to explain the simultaneous existence of alternative organizational designs, i.e., firms, markets, and hybrid mechanisms for conducting transactions.[112] The establishment of collaborative ventures (as a form of hybrid organization) involves transaction costs at two distinct levels: On one hand, transaction costs may play an important role in explaining the choice of hybrid over hierarchical (i.e., intra-organizational) or market-based (i.e., arm's length) transactions. On the other hand, transaction-cost

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[111] More specifically, (Williamson 2000) identifies four levels of NIE. The first and second levels, embeddedness and the institutional environment, provide the general background of economic activity. TCE (and to some extent also agency theory) constitutes the third level, since it targets the alignment of governance structures and transaction characteristics. Agency theory, for the most part, is part of the fourth level, the marginally optimal allocation and employment of resources.

[112] The general TCE framework is based on the pioneering work of (Coase 1937) and has been further developed starting in the 1970s, most notably by (Williamson 1975, 1985). For recent reviews of TCE, see (Rindfleisch and Heide 1997), (Slater and Spencer 2000), and (Madhok 2002), among others. Furthermore, (Shelandski and Klein 1996) and (Rindfleisch and Heide 1997) assess of the empirical evidence regarding TCE. Also see Table 44 in the appendix for a further discussion of the general intent and critique of TCE.

considerations may affect the design of collaborative structures, i.e., the choice of contractual alliances vis-à-vis equity-based JVs (including minority equity stakes) [e.g., (Hagedoorn 1990), (Osborn and Baughn 1990)].[113] At either level, transaction cost efficiency depends on the match of an organizational design's cost profile to the given transaction context.

First, alternative transaction mechanisms are associated with quite dissimilar direct and indirect costs of conducting a given transaction.[114] Direct costs are incurred to initiate and manage an exchange relationship. These, for instance, include the ex ante costs of drafting and negotiating contracts as well as the ex post costs of monitoring and enforcing them. Indirect (or opportunity) costs of organizing transactions inefficiently also form part of the overall transaction costs. The direct costs of a market transaction are limited to the search for and screening of transaction partners, the negotiation and the monitoring of contract terms. However, market transactions may leave a party susceptible to partner opportunism, since they are only safeguarded to the extent that formal contract provisions are enforceable in a court of law. Contrarily, hierarchical coordination may rely on a wider array of tools for adaptation and ensuring cooperative (i.e., non-opportunistic) behavior (e.g., internal dispute resolution) [cf. (Williamson 1999a)]. However, the increased level of control incurs higher bureaucratic (i.e., direct transaction) costs.

Hybrid forms of transaction governance take an intermediate position in the trade-off between direct and indirect transaction costs [cf. (Jones and Hill 1988)]. Specifically, collaborating firms are mutually dependent and will thus have an incentive to abstain from opportunistic behavior towards the alliance partner.[115] However, these advantages require interorganiza-

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113 In this context, (Tallman and Shenkar 1994) describe the two-stage decision making process leading to cooperative arrangements. Similarly, (Hennart 1988) points out that joint ventures are only sensible (a) to circumvent inefficient markets and (b) if they are superior to contracts, acquisitions, or Greenfield investments. Consequently, efficient decisions at both levels are required for transaction cost minimization.

114 The existence of transaction costs hinges on three basic behavioral assumptions, which diverge substantially from the neoclassical market perspective: Bounded rationality, opportunism, and risk neutrality. In particular, transaction costs exist, since boundedly rational individuals cannot ex ante prevent transaction partners from behaving opportunistically. Table 45 of the appendix provides a summary of the three behavioral assumptions.

115 (David and Han 2004) point towards hybrid forms of governance as providing a “tolerance zone” (p. 40) of adaptation, information disclosure, and conflict resultion. (Rindfleisch and Heide 1997) suggest that the details of these intraorganizational governance costs have only briefly touched upon in existing

tional coordination, the costs of which are higher than in market-based transactions but lower than for hierarchies.

Akin to the choice of market, hybrid or hierarchical governance, different collaborative structures possess heterogeneous transaction cost profiles. As outlined by (García-Canal 1996), equity-based alliances and joint ventures are more hierarchical and thus induce higher (direct) ex post coordination costs, whereas contractual alliances are associated with (direct) ex ante costs of contract specification as well as the (indirect) costs of misspecification.

Second, the relative efficiency of market, hierarchical, and hybrid transaction modes results from their alignment with the specific transaction context [cf. (Williamson 1985, 1999a)]. In particular, the levels of (environmental) uncertainty, specific investments, and transaction frequency represent key drivers of transaction costs. Uncertainty and asset specificity open the door for opportunistic exploitation and thus induce a need for more stringent control. In addition, the frequency of transaction increases the attractiveness of hierarchical coordination through fixed-cost digressions.[116] While high environmental uncertainty, highly specific investments, and high transaction frequency thus favor hierarchical control as opposed to market-based transactions, hybrid arrangements are efficient organizational forms for intermediate levels of uncertainty, asset specificity, and transaction frequency.[117] Similarly, asset specificity, uncertainty, and expected frequency of collaboration increase the complexities of collaboration, i.e., render it more difficult to plan for future states of nature and costly not to account for potential transaction hazards. Consequently, such circumstances favor JVs, whereas ‘simpler’ agreements are efficiently are organized as contractual collaborations.[118]

TCE research, but may be substantial, including management compensation, incentive payments etc..

116 For further details on the three determinants of transaction costs, see Table 46 in the appendix. Note that since boundedness of rationality, opportunistic predispositions, and risk preferences are assumed to be constant across a great number of transactions [cf. (Hill 1990)], they not differentially affect the individual transaction governance mode choice.

117 Note, however, that extremely high levels of environmental uncertainty may have an inverse effect, since the flexibility inherent in market transactions may counterweigh the risk of opportunism. Hybrid forms may not be suitable under such conditions, since they require bilateral adaptation [cf. (Shelanski and Klein 1995), as well as the empirical evidence cited by (Rindfleisch and Heide 1997)].

118 While transaction-cost arguments are very prevalent in academic literature on collaboration governance, a variety of other factors may also be relevant deci-

Reasoning 3:	The appropriation of collaborative value requires efficient choices of hybrid (over hierarchical and market-based) transaction governance and contractual or equity-based collaboration, i.e., minimizing transaction costs in a given context.

On an aggregate level, empirical literature supports the notion of transaction costs requiring specific transaction structures to protect collaborative benefits. For instance, (Brockhoff 1992) finds alliance success being negatively related to perceived transaction costs.[119] Similarly, (Parkhe 1993b) shows perceived opportunistic behavior having a significantly adverse effect on collaborative performance. More specifically, (Sampson 2004a) distinguishes whether collaboration schemes are aligned with the respective transaction conditions. Transactions organized in line with the contextual necessities outperform 'misaligned' collaborations by 61%, on average.[120]

2.3.1.2 Asset Specificity, (Environmental) Uncertainty, and Transaction Frequency

TCE predict that moderate asset specificity, environmental uncertainty, and transaction frequency are conductive to collaborative activity. Addi-

sion parameter. For example, (Desai et al. 2002) document ownership restrictions, tax rate differences, and the reliance on host- or home-country resources affecting the choice of internal, equity-based, contractual or market-based transaction modes. Similarly, (García-Canal 1996) suggests that the complexity of a collaboration depends the number of partners in addition to its duration, international scope and functional areas involved, in particular whether it relates to the transfer of knowledge resources.

119 Additionally, he shows perceived transaction costs being higher for contractual agreements (as opposed to EJVs). Note, however, that (Brockhoff 1992) studies technology-related collaboration only. As will be argued in subsection 2.3.1.1, such transactions are subject to a high degree of asset specificity, i.e., they tend to be associated with higher transaction costs and better suited for equity-based contracts.

120 In particular, (Sampson 2004a) predicts the use of equity-based or contractual forms using a model incorporating cooperation and environmental characteristics such as scope of joint activities and intellectual protection regimes. Equity joint-ventures employed in conditions allowing contractual alliances (based on these predictions) have a two- to three-times lower patent performance. Conversely, pooling contracts in situations requiring more hierarchical governance only marginally decrease collaborative benefits. (Sampson 2004a) uses citation-weighted patent count as performance measure.

tionally, higher levels of these influences favor equity-based as opposed to contractual forms of collaboration. This section further explores the empirical evidence on these issues.[121]

Asset Specificity

In a collaborative context, the predominant type of specificity relates to technological knowledge.[122] Specifically, R&D alliances may induce higher transaction costs due to the risk of knowledge spillovers and difficulties of coordinated knowledge exchange (or creation). Additionally, the extent of transaction costs may be related to the collaborating firms' knowledge stocks [cf. (Gatignon and Anderson 1988)].

On a transaction level, numerous prior studies have observed that R&D-related collaborations are more likely established as EJVs rather than contractual arrangements [e.g., (Gulati and Singh 1998), (Gulati 1995a), (Osborn and Baughn 1990), (Pisano 1989)].[123] Similarly, (Sengupta and Perry 1997) show joint upstream (i.e., R&D, manufacturing etc.) more likely organized as JVs than downstream activities (i.e., marketing/

121 In their recent meta-analysis of empirical TCE literature, (David and Han 2004) observe rather ambiguous empirical evidence regarding the predictions of transaction cost theory. Regarding the choice of hybrid forms of governance supportive (16) and opposed studies (14) nearly offset. Hypotheses regarding the effectiveness of hybrid coordination are largely supported by prior research (63% or 5 of 8 studies in favor, none opposed). The choice and performance of collaborative agreements, however, only makes up a small share of the entire empirical research in the field. Most prior evidence addresses the choice between market and hierarchy (117 of 308 tests).

122 More generally, all assets that are specific to a given use leave room for opportunism and thus incur transaction costs. Physical, human, and brand name assets may site-specific, dedicated or temporally specific for a given transaction [cf. (Williamson 1991)]. Given the scope of this thesis and its focus on a knowledge-intensive industry, other types of specific assets are not considered further.
Evidence on marketing expenditures as a proxy for asset specificity are similar. For instance, (Moon 1999) and (Lu 2002) find a firm's marketing intensity increasing its reliance on proprietary strategies (i.e., M&A and wholly owned subsidiaries rather than JVs, respectively). (Ingham and Thompson 1994) show specific marketing assets positively related to proprietary market entry. Finally, (Dai and Kaufmann 2004) find that vertical alliances between B2B marketplaces and their customers are more likely equity-based or exclusive.

123 (Pablo and Subramaniam 2002) provide concurrent findings for different types of knowledge-related alliances, distinguishing joint R&D, technology transfer, and product development. Conversely, (García-Canal 1996) finds R&D alliances more likely organized as contractual agreements than joint ventures.

distribution, aftersales etc.). (Rothaermel 2001) finds stronger ties (i.e., equity as opposed to non-equity forms of cooperation) yielding greater product development success. Consequently, firms choose JV structures to mitigate the transaction costs associated with R&D collaboration and JVs appear to effectively do so.

The relative importance of a given collaborative project may magnify firms' misappropriation concerns.[124] In this context, (Oxley 1997) and (Oxley and Sampson 2004) show incremental (as opposed to fundamental) collaborative R&D projects to be significantly less often organized as an equity JV. (Sampson 2004a) extends these findings to far-reaching (i.e., next generation) R&D as well as for alliances involving joint marketing and/or production in addition to R&D cooperation.[125] Finally, the above effect of important innovations increasing the formation of collaborative ventures documented by (Ahuja 2000b) [see subsection 2.2.2.1] extends only to JVs but not contractual research agreements.

Proposition 3.1a:	The appropriation of collaborative value requires more restrictive (equity-based) hybrid governance, when agreements address R&D activities; in particular, if projects are strategically important.

On a firm level, several studies observe that R&D investments may lead firms to choose proprietary over cooperative strategies [e.g., (Yiu and Makino 2002), (Gatignon and Anderson 1988)]. The valuable, intangible resources created by such investments may be at risk of expropriation or require additional coordination in collaborative arrangements. More specifically, (Combs and Ketchen 1999b) find firms abstaining from collaboration under adverse exchange conditions (high knowledge specificity, low (partner) asset specificity and low internal coordination costs), unless

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124 Similarly, (Hagedoorn and Duysters 2002a) find that firms use M&A rather than cooperative or mixed strategies, when transacting in their core businesses. (Pisano 1991) also finds firms having a particularly strong focus on the pharmaceutical business (measured as % of its total sales) being more likely to perform R&D activities internally rather than as cooperative ventures.

125 At the same time, (Sampson 2004a) finds alliances narrowly focused on exploiting existing technologies also being more often organized as JVs compared to alliances of intermediate scope. While this is counterintuitive from a transaction-cost perspective, (Sampson 2004a) argues that it may reflect a higher propensity of narrow alliances being international and thus requiring greater coordination. As such, (Sampson 2004b) shows no difference in the governance of alliances addressing narrow and intermediate R&D activities in purely domestic alliances. (Note: both publications analyze the telecommunication equipment industry over the 1991-1993 time period)

they are forced to cooperate due to a lack of internal resources. Those firms collaborating in spite of unfavorable exchange conditions were punished by means of substantially decreased performance.[126] While evidence on firm R&D investments thus supports asset specificity considerations, two characteristics of the particular dyadic relationship may moderate these effects:

First, opportunistic incentives are greatly reduced by reciprocal dependence among cooperation partners, i.e., if all parties have a similar exposure to transaction risks [cf. (Teece 1986), (Heide and John 1988)]. Along those lines, (Parkhe 1993b) argues that investments in specific assets serve as ex ante deterrents to opportunism. Based on survey data, he observes a significant negative relationship between non-recoverable investments made by the transaction partner and observed opportunism as well as a positive effect on reported performance. Similarly, (Combs and Ketchen 1999b) demonstrate a significantly positive impact of (bilateral) physical asset specificity on the likelihood of allying.

Proposition 3.1b:	The appropriation of collaborative value requires more restrictive (equity-based) hybrid governance, when asset specificity creates expropriation risks, unless investments are bilateral and/or knowledge relatedness is limited.

Second, technological similarity may render knowledge more easily appropriable (or expropriable). In this respect, (Subramanian 2004) shows firms with similar patent portfolios (and overlapping industry activities) choosing more restrictive (i.e., hierarchical) forms of governance.[127] Con-

126 (Moon 1999) shows R&D intensive firm to favor joint ventures over acquisitions and (Lu 2002) shows R&D intensity having no significant effect on the choice of market entry mode. This may, however, be specific for the choice between joint venturing and full-blown acquisitions. In this context, (Gulati 1995a) and (Anderson and Gatignon 1986) argue that specific knowledge (developed through R&D expenditures and affected by R&D alliances) is subject to asymmetric information regarding its usefulness and value. This notion is at the root of agency conflicts and will be further addressed in section 2.3.2.
Since both (Moon 1999) and (Lu 2002) specifically refer to international cooperative ventures, the transaction costs of specific knowledge assets may also be overcompensated by other factors, e.g., firms utilizing collaboration as a means to internationalize.

127 This is in line with the facilitating effect of absorptive as well as the resulting risk of intra-alliance competition and learning races [see subsection 2.2.2.4]. However, (Subramanian 2004) argues based on learning incentives rather than knowledge protection, specifically that knowledge similarity requires greater

currently, (Sengupta and Perry 1997) observe partners with different industry origins (i.e., different 2-digit SIC codes) favoring contractual arrangements. More specifically, (Sampson 2004b) finds the choice of equity-based transaction modes to first increase with technological diversity, then to decrease (inverse U-shape). While the former suggests increasing risk of knowledge spillovers or misappropriation, the latter may reflect the lack of absorptive capacity if partners are highly unrelated. Moreover, (Sampson 2003) shows the positive (but marginally declining) effect of cooperating firms' technological diversity on innovation performance to be vastly more pronounced in equity joint ventures.[128] This suggests that the full benefit of mutual learning may only be realized if appropriate governance schemes are implemented.

Environmental Uncertainty

From a TCE perspective, environmental uncertainty may necessitate hierarchical governance forms, since they provide elaborate adaptation mechanisms and additional protection from opportunism. Environmental uncertainty is reflected on two different levels: On one hand, certain industry traits may reflect dynamically changing market conditions. On the other hand, firms' perceived level of uncertainty may be quite different depending on firm size.

Most prominently, industry R&D-intensity (i.e., R&D-to-Sales ratios) is indicative of technological uncertainty.[129] R&D-intensive industries also

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access (such as through JVs or hierarchical integration). Conversely, integration of dissimilar knowledge would induce inefficient overinvestment, i.e., such transaction are best handled at arm's length or through contractual collaboration.

128 Note that the choice of governance mode itself exerts no significant influence on innovation performance. Therefore, the primary strength of joint ventures lies in its facilitation of transactions among technologically distant partners. Conversely, (Sampson 2004a) does not document a significant effect of technological diversity on governance mode choice, when controlling for country-specific factors in international alliances.

129 In addition, demand uncertainty may reflect greater expropriation risks. In this context, (Moon 1999) observes a positive effect of industry marketing intensity on the choice of acquisitions over JVs. For advertising intensive industries, he also documents a similar effect of firm-level marketing intensity. This mirrors the risk of brand capital misappropriation in highly competitive markets. Brockhoff (1992) also documents higher perceived transaction costs for late technology life-cycle stages, which may reflect high demand uncertainty in declining markets. Convsersely, (Subramanian 2004) tests for effects of av-

appear to favor collaborative market entry over acquisitions and fully owned subsidiaries [(Moon 1999) and (Desai et al. 2002),[130] respectively]. Similarly, high-tech sectors rely more heavily on strategic alliances, whereas low-tech industries tend to choose M&A transactions [(Hagedoorn and Duysters 2002a)]. Various studies provide evidence of R&D intensity being associated with a heavier reliance on contractual alliances compared to equity JVs [e.g., (Osborn and Baughn 1990), (Sengupta and Perry 1997)].[131] Finally, Brockhoff (1992) documents higher perceived transaction costs in early life-cycle stages. These findings suggest that, faced with high environmental uncertainty, firms tend to collaborate and choose rather flexible forms of governance. In contrast to the standard TCE rationale this suggests that the benefits of joining technological resources (e.g., bilateral asset specificity) and the medium- to long-term perspective of technological collaboration may sufficiently offset the misappropriation risks of environmental uncertainty.[132]

Proposition 3.2:	The appropriation of collaborative value requires more flexible (contractual) hybrid governance in technologically uncertain environments.

Firm size may moderate the level of perceived uncertainty, since larger firms will generally be less threatened by a given risk level. This is supported by (Osborn and Baughn 1990) showing a statistically significant effect of the interaction between industry R&D intensity, joint R&D as transaction focus, and at least one small firm being involved. Conversely, (Ingham and Thompson 1994) find large, well-endowed firms to more

erage industry advertising and capital intensity, but finds both being insignificant.

130 Note that (Desai et al. 2002) regard industry R&D intensity as reflection of asset specificity. Their findings would thus oppose the above evidence on firm-specific R&D investments. While Moon (1999) finds the primary effect of industry R&D intensity insignificant, firm R&D intensity favors less hierarchal governance in R&D intensive industries.

131 Only (Subramanian 2004) finds industry volatility, R&D-to-sales intensity, and average tobin's q inducing hierarchical control.

132 Several approaches may alternatively explain these findings. From a learning perspective [see subsection 2.2.2.4], collaborative modes of organization may allow to profit from partner resources or jointly generate knowledge. From an evolutionary perspective, it may be the primary objective of firms to achieve a satisfactory technological positioning. Reserving the 'right to play' through flexible alignments and multiple linkages may make the protection of proprietary knowledge an afterthought [e.g., (Osborn and Baughn 1990)]. Subchapter 2.4 builds on this perspective.

likely internalize transactions bearing (credit) risks and requiring substantial initial investments. More generally, (Hagedoorn and Duysters 2002a) find firm size negatively related to the usage of M&A transactions (relative to cooperative strategies). Evidence on the net effect of firm size thus remains inconclusive.

Transaction Frequency (Scope)

While transaction frequency itself has not been explicitly considered in studies of hybrid organizations, the scope of collaborative activities may have a significant impact on the choice of transaction governance. It reflects the extent and complexity of interactions between transaction partners [(Gulati and Singh 1998)] as well as greater risk of misappropriation of specific assets [cf. (Oxley and Sampson 2004)]. Managing and controlling broader collaboration thus incurs substantially higher costs of coordination. The complexity of such transactions may best be handled using restrictive governance modes, e.g., JVs rather than contractual alliances.

Empirical evidence broadly supports this perspective. (Gulati and Singh 1998) show that transactions extending beyond the mere pooling of resources are more often organized as JVs than contractual arrangements. Additional interaction among collaborators creates a dependency on partner actions and thus requires greater coordination and adaptation.[133] Similarly, (García-Canal 1996) finds that collaboration involving multiple functional areas is more likely organized as JVs.

At the same time, transaction scope is itself an endogenous factor, since collaborating firms have great latitude to include or withhold particular activities from an agreement. In this context, (Oxley and Sampson 2004) suggest that collaborating firms may choose to limit the scope of an alliance in response to risks of expropriation (i.e., high transaction costs). Specifically, they find partnering firms overlapping in geographic and/or product-market terms tending to reduce alliance scope, in particular excluding joint marketing activities.[134] Similarly, (Anand and Khanna 2000b)

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[133] Such interaction may be sequential as well as reciprocal. Reciprocal interdependence [cf. (Borys and Jemison 1989)] is associated with the sharing of complementary technologies and joint development of new technologies. At first sight, this evidence might thus appear to reiterate the above findings relating to the asset specificity of R&D cooperation. However, sequential interaction such as required for market access, distribution or supply alliances also leads to an increased use of hierarchical controls [cf. (Gulati and Singh 1998)].

[134] While market and geographic overlap do significantly reduce the likelihood joint manufacturing being included in an R&D alliance, (Oxley and Sampson 2004) find them to also increase the use of equity joint-ventures.

provide evidence of licenses less likely being exclusive in the (ex post) licensing of existing technologies and in cross-border transactions. Additionally, (Subramanian 2004) finds an industry's capital intensity (capex-to-sales ratio) reducing the extent of access to proprietary technologies.[135] All of these findings suggest that in addition to inducing the need for more formal governance, market-related asset specificity and uncertainty may lead firms to reconsider the scope of their collaborative activities.

Based on the documented findings, the choice of transaction scope and governance may be interdependent. Along these lines, (Desai et al. 2002) suggest that the access to (or transfer of) intangible assets is broader in wholly or majority-owned affiliates compared to 50-50 and minority JVs.[136] (Oxley and Sampson 2004) explicitly demonstrate reciprocally significant effects between equity-based governance and transaction scope. More specifically, their evidence suggests that firms choosing joint manufacturing for technological (or need-based) reasons, and rely on equity-based governance to mitigate the arising transaction costs. Conversely, they may refrain from including joint marketing in alliances with competing firms, since this would otherwise incur high transaction costs.

Proposition 3.3:	The appropriation of collaborative value requires matching choices of narrow or broad transaction scope and contractual or equity-based hybrid governance, respectively.

2.3.1.3 Other Determinants of Transaction Structure

While the above arguments focused on transaction costs due to opportunistic threats, empirical literature has also identified other influences on the

135 As above, technological uncertainty does not appear to have such an effect. Specifically, (Subramanian 2004) does not observe partners in high R&D intensity industries or with overlapping activities and IP portfolios granting their transaction partners less extensive access to proprietary technologies. (Oxley and Sampson 2004) even show that technological overlap (i.e., the similarity of collaborating firms' patent portfolios) is linearly associated with larger alliance scope (i.e., R&D collaborations among technologically similar firms often also include joint manufacturing activites).

136 (Desai et al. 2002) use the amount of the royalties paid to the parent firm (i.e., the legal entity providing technology access) as a proxy for the extent of technology access. Higher royalty payments are also associated with R&D intensiveness, reflecting the need for the knowledge transfers. Finally, R&D intensiveness and whole/majority ownership interact significantly with regard to the provision of intangible assets (i.e., royalty payments).

choice of alternative governance schemes. In particular, coordination costs vary across different international settings and based on prior experience with a given transaction scheme.

The costs of international coordination may be lower for firms possessing sufficient knowledge of the local market.[137] First, coordination may be easier between partners from geographically and culturally related countries. (Gulati and Singh 1998) substantiate this argument by showing that collaborative arrangements between European firms and between Japanese firms are more likely to take the form of contractual alliances than intercontinental agreements. Similarly, (Sengupta and Perry 1997) document collaboration involving U.S. and either European or Japanese partners relying more heavily on equity-based governance than between U.S. firms. At the same time, (Moon 1999) shows that the cultural distance between the focal firm's home and target countries increases its reliance on joint ventures (compared to M&A). (Yiu and Makino 2002) find both ethnocentricity and cultural distance being positively related to joint venturing (as opposed to proprietary market entry).[138] Consequently, JVs may provide internationalizing firms sufficient control (vis-à-vis contractual collaboration), while giving access to local firms' market know-how (as opposed to M&A/Greenfield investments).

Second, prior presence in the host country may reduce the coordination costs of additional international transactions. Prior studies find several different measures of international experience associated with proprietary rather than cooperative strategies, including a firm's host country experience [e.g., (Hennart and Reddy 1997), (Yiu and Makino 2002)] as well as its cultural diversity, i.e., overall exposure to international contexts [(Moon 1999)].[139] Overall, local market know-how and international experience

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137 Of course, the choice of market entry mode may also be affect by various country-specific factors. For instance, (Desai et al. 2002) show differences in international tax rates increasing the likelihood of fully-owned market entry. Under such conditions, international tax management (e.g., through intra-firm transfer pricing) allows to increase after-tax profits under such conditions, representing opportunity costs of non-proprietary ventures.

138 (Glaister/Buckley 1996), however, do not show cultural distance to significantly affect alliance satisfaction, whereas partner behavior is the primary determinant. Consequently, the use of equity-based governance may be successful in mitigating the increased risks associated with culturally dissimilar alliance partners.

139 As one contradictory finding, (Lu 2002) shows firms' prior experience in a given country to increase the likelihood of joint venturing, and international experience in general having no significant effect. Such observations suggest that the effects of international experience may not be linear. For instance,

may render proprietary operations more attractive than cooperative ventures.

Proposition 3.4a:	The appropriation of value from international market entry requires less flexible (hybrid) transaction governance given prior international experience and host-country presence.

Coordination costs may also be lower for firms having prior experience with a specific transaction mode, leading to history-dependence in transaction patterns. For instance, (Hagedoorn and Duysters 2002a) show that firms having over-proportionally (relative to the respective industry average) relied on either strategic alliances or M&A transactions continue to predominantly use that type of approach.[140] (Yiu and Makino 2002) document similar path-dependence in the transaction mode choices of firms having previously employed JVs. (Lu 2002) distinguishes country- and industry-specific entry mode experience (i.e., the share of prior transactions using the given scheme) and finds both significantly increasing the subsequent choice of that same mechanism.[141]

Similar to historical norms, (Gulati 1995a), (Yiu and Makino 2002), and (Lu 2002) show that firms' choices of JVs over proprietary market entry are subject to mimetic behavior, i.e., positively related to other firms' precedents. The more competitors rely on JVs, the more firms tend to follow suit. (Lu 2002) suggests this effect being driven by firms imitating the successful market-entry strategies of similar companies (i.e., other Japanese enterprises as opposed to less successful Japanese and successful international firms). Finally, (Lu 2002) also addresses the interaction of historical path-dependence and mimetic behavior. Specifically, the level of prior experience in a given (country or industry) market reinforces the his-

(Desai et al. 2002) observe that firms operating in a great number of countries have a preference for JVs, which may reflect increasing coordination costs of large subsidiary networks.

140 Additionally, (Hagedoorn and Duysters 2002a) find firms having previously used both approaches preferring either strategic alliances or M&A transactions over continuing a mixed strategy. This suggests that, with experience, firm learn to favor transaction schemes meeting their needs rather than merely apply standard practices.

141 For R&D alliances, (Hernán et al. 2003) document a significantly positive influence of prior participation in cooperative R&D programs on the likelihood of further research JVs. Conversely, (Pisano 1991) shows no significant effect of biotechnology firms' internal and/or external R&D history on the choice of in-house versus external research.

torical path dependence while negating the mimetic effect of other successful market entrants. Consequently, imitation primarily serves as a substitute for inexistent first-hand experience.[142]

All in all, this evidence posits that firms learn to choose efficient transaction schemes. Additionally, path-dependence may reflect decreasing costs of coordination with growing experience in the most suitable transaction mode, e.g., through firm routines for JV management. A similar logic may be applied to the substantive benefits of alternative governance schemes:

Proposition 3.4b:	The appropriation of collaborative value is linked to firm experience in the given governance mode and (in the absence thereof) to successful precedents of other firms in similar contexts.

2.3.2 Agency and Game Theories of Cooperation

2.3.2.1 Fundamentals of Agency Relations in Corporate Collaboration

While TCE focuses on the efficient conduct of transactions, the unit of analysis in agency theory is the dyadic relationship between transaction partners. Agency relationships refer to situations in which one party (the principal) relies on another party (the agent) to perform certain tasks or to provide certain goods. Generally, information relevant to transaction success is distributed asymmetrically between the two parties, with the agent being in a privileged position. This enables her to benefit at the expense of the principal.[143]

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142 (Koza and Lewin 1998) argue in support of this logic. They suggest that mimetic behavior will occur if firms lack own prior experience, whereas past alliance success will induce greater persistence in alliance-formation behavior. Alternatively, mimetic behavior may be an attempt to gain organizational legitimacy [cf. (DiMaggio and Powell 1983)], i.e., being recognized as following prevailing market rules and business norms. Both aspects are often referred to as institutional theories, which are not limited to the choice of governance mode and will be further addressed in subchapter 2.4.

143 The fundamental, behavioral assumptions of agency theory are closely related to TCE. Agency problems would not exist, if the principal's rationality was unbounded or if the agent was not self-interested enough to opportunistically pursue her goals. For more thorough reviews of the similarities and differences between TCE and agency theory, see (Williamson 1988) and (Bergen et

More specifically, two types of information asymmetries exit in agency situations. On one hand, the agent may be better informed with regard to existing characteristics of the transaction object, the market environment, or the agent's capabilities. Such hidden characteristics may result in a situation of adverse selection, i.e., principals systematically receiving worse-than-expected quality. On the other hand, the agent's information advantage may pertain to her behavior after the initial transaction takes place. Hidden action, i.e., unobservable agent behavior, may exert a moral hazard, i.e., be an incentive for the agent to behave opportunistically.[144] In the present context, agency relations of either type may be diverse, but most prominently exist between the collaborating firms. Depending on the extent of information asymmetries, they may lead to inefficiencies or even outright market failure [e.g., (Akerlof 1970)], i.e., firms altogether abandoning their intent to collaborate. Consequently, both principals and agents stand to gain from a cooperative solution.

Adverse selection and moral hazard problems may be resolved. On one hand, the principal may engage in (ex ante) screening[145] and (ex post) monitoring activities to actively reduce the extent of information asymmetries. Partner selection and alliance management may be important tools in collaborative settings. On the other hand, the agent may signal her quality or the principal may employ contract designs targeting an alignment of interest between both parties.[146] Along those lines, alliance contracts may account for potential information asymmetries.

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al. 1992), among others. (Hart and Holmstrom 1987) and (Kreps 1990), among others, provide extensive reviews of agency theory.

Finally, game theory provides the modeling tools for assessing the outcomes of agency situations. While it is not generally discussed here, contractual incentives, signalling, and trust are rooted in game theory. A broad overview is provided by (Fudenberg and Tirole 1991), among others.

144 See Table 47 of the appendix for a summary of hidden characteristics and hidden action. Interestingly, situations in which both parties reciprocally rely on each other (i.e., two-sided agency problems) are conceptually equivalent to the Prisoners' Dilemma concept fundamental to game theory [cf. (Parkhe 1993b)].

145 Explicit screening of alliance partners has received little consideration in prior research. Regarding the formation phase, (Child and Yan 2003) providing evidence of Chines firms' profiting from extensively assessing alternative partners, but no such effect for the U.S. partner or the overall time allowed for IJV formation. This suggests that screening may be limited to the general alliance formation issues discussed here.

146 The latter may include both (ex ante) self-selection, i.e., conditions to which only certain types of agents will agree, as well as (ex post) incentives rendering collaborative behavior beneficial to both parties.

Reasoning 4:	Information Asymmetries may hamper collaborative value creation unless specific measures mitigate them or align principal and agent objectives.

The following subsections further elaborate on the information asymmetries relevant to corporate collaboration (2.3.2.2) and on corresponding solution mechanisms (2.3.2.3).

2.3.2.2 Alliance-Related Information Asymmetries

In contrast to the transaction cost approach above, agency theory has not been applied consistently in collaborative contexts. For the purpose of the thesis, two different types of agency relationships are relevant. Before (re)focusing on the intra-alliance perspective, the effects of collaborative ventures on other firm-level agency relationships will be addressed.

Alliances and Extra-Alliance Information Asymmetries
Information asymmetries exist between companies' management and their shareholders. For instance, moral hazards may materialize in management growing or diversifying the firm beyond an economically reasonable scale/scope. Along these lines, numerous authors have documented value destruction in M&A transactions, in particular, when management is not sufficiently controlled or incentivized to act in the best interest of its shareholders [e.g., (Amihud and Lev 1981), (Demsetz and Lehn 1985), (Shleifer and Vishny 1996)]. In the context of corporate collaboration, (Reuer and Ragozzino 2006) document significantly higher rates of joint venture and alliance formation for firms without substantial managerial shareholdings or financial leverage.[147] This evidence may suggest that management may invest in collaborative ventures to pursue private benefits, such as personal reputation.

Firm-level information asymmetries also extend to the relationship with other capital market participants. Unobservable firm quality constitutes an adverse selection problem in lending and investment decisions. In particular, credible signals may be required to overcome the adverse selection risks associated with the public common stock offerings [e.g., (Carter and

[147] The general findings presented by (Reuer and Ragozzino 2006) are consistent for international and domestic transactions (both contractual and equity-based) as well as across various model specifications. Additionally, potentially confounding firm and industry-level factors are controlled for, underscoring a linear unmediated/ moderated effect of managerial ownership. However, the findings may not be easily generalized, since they draw on a the sample of U.S. manufacturing firms, only.

Manaster 1990), (Podolny 1994)]. For instance, For the case of alliances, (Stuart et al. 1999) indicate that alliances with prominent partners may provide young firms with the legitimacy needed for swift IPOs.[148] Alliances thus may serve as signals of firm quality, helping to mitigate other external agency problems [e.g., (Häussler 2005)].

In summary, extra-alliance information asymmetries may both reduce and increase anticipated collaborative benefits. The controversial arguments (and evidence) may each be relevant for different types of firms. On one hand, alliance formation may reflect agency hazards if the substantive value of collaboration is limited, e.g., for established firms in rather stable environments such as the U.S. manufacturing sector studied by (Reuer and Ragozzino 2006). On the other hand, the signaling effect may dominate under comparably uncertain conditions, such as the small DBF setting considered by (Stuart et al. 1999).[149]

Proposition 4.1a:	Information asymmetries between management and shareholders reduce collaborative value creation, since alliances may yield private managerial rather than shareholder benefits.
Proposition 4.1b:	Information asymmetries between focal firms and capital markets compound collaborative value creation, since partner reputation serves as a signal for unobservable firm quality.

Alliance Formation and Intra-Alliance Information Asymmetries

Agency theory suggests that information asymmetries between prospective alliance partners may reduce collaborative benefits and, at worst, prevent alliance formation: The greater the information asymmetries, the more difficult and costly it is for principals to validate agent quality and behavior.

148 The effect of non-equity alliance partners' reputation is, however, only significant in interaction with a dummy variable for very young firms (<3 years). Neither technological nor commercial partner prominence in isolation exhibit significant effects on time-to-IPO.

149 Additionally, both private managerial benefits and signalling effects are additive to the substantive benefits of collaboration. That is, neither do private managerial benefits exclude the possibility of simultaneous benefits to shareholders, nor do positive signalling effects guarantee them. Consequently, (Reuer and Ragozzino 2006) agree that the negative and significant effect of managerial stock-ownership on the formation of domestic contractual alliances is surprising in light of the generally positive value generated.

The magnitude of agency costs thus varies with the uncertainty surrounding the agent as well as the ability of the principal to assess partner quality.

First, if information available on partnering firms is limited, principals may discount agent compensate or require more restrictive governance. In particular, the value of the agent's technological resources may be difficult to assess ex ante. (Nicholson et al. 2002) observe that biotechnology firms are faced with significant discounts, when entering into their first alliance with a major pharmaceutical firm.[150] (Robinson and Stuart 2002) indicate that collaborating firms' network centrality reduces the need for equity-based governance and increases the cash-payments they receive in alliances [also see subsection 2.2.2.3, in particular FN 91]. Similarly, (Coombs and Deeds 2000) observe patents and successfully advanced development projects are positively related to financial inflows from alliances [also see subsection 2.2.2.2, in particular FN 79]. All this evidence points towards young high-technology firms requiring external validation to fully reap collaborative benefits.

Second, the principal's prior experience in or close relatedness to the area of collaboration reduce perceived agency costs. (García-Canal 1996) finds collaborations, in which at least one partner enters a new product market, more likely organized as JVs than contractual agreements. That is, inexperienced partners may require more restrictive collaborative governance. In contrast, the evidence on the choice of collaborative as opposed to proprietary market entry is contradictory. On one hand, (Desai et al. 2002) observes firms preferring fully-owned rather than joint venture market entry when diversifying. On the other hand, (Pisano 1991) shows that firms possessing prior experience in a specific technological field are more likely to internalize R&D activities.[151] Similarly, prior experience may allow firms to better collaborate [e.g., (Moon 1999)] or to better value other firms, facilitating M&A transactions [cf. (Balakrishnan and Koza 1993)].[152]

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[150] This situation may present firms with the dilemma of having to disclose information on their achievements in order to convince transaction partners of their scientific capabilities, which simultaneously imposes a risk of involuntary knowledge transfer.

[151] To round out the picture, (Lu 2002) documents no effect of prior industry experience. Also, (Moon 1999) finds that transactions outside the focal firms' primary business are not more likely JVs than acquisitions.

[152] More generally, (Balakrishnan and Koza 1993) argue that asymmetric information prevent one firm from accurately valuing another, which favors JVs. Conversely, (Hennart and Reddy 1997) suggest that difficulties in separating target firm resources may be the primary reason for collaborative ventures being preferred to acquisitions ['indigestibility' problem]. The resulting contro-

In summary, existing information asymmetries appear to reduce collaborative benefits, but the role of prior experience remains unclear.

Proposition 4.2:	Information asymmetries between collaborating parties reduce collaborative value creation by hindering principals' ability to adequately value (and compensate) agents' contributions.

2.3.2.3 Contractual Safeguards and Trust in Strategic Alliances

For firms to enter into collaborative agreements, they need to sufficiently garner confidence in each other. In contrast to the above information asymmetries, such confidence reflects "a firm's perceived certainty about satisfactory partner cooperation" [(Das and Teng 1998), p. 492]. Moreover, (Das and Teng 1998) distinguish two sources of partner confidence in a collaborative context: Control and trust. While control is grounded in structural or contractual safeguards,[153] trust may evolve from prior interactions or reputation effects.

Contract Design in Strategic Alliances

Contractual control mechanisms have a long tradition in various agency-related contexts, such as venture-capital financing [cf. (Kaplan and Strömberg 2004); as well as (Triantis 2001) for a review]. With regard to strategic alliances, (Parkhe 1993b) identifies information rights, confidentiality provisions, termination arrangements, and arbitration clauses as relevant contract constituents. (Luo and Tan 2003) conclude that the overall completeness of contracts (i.e., across diversity, clarity, and flexibility dimensions) may be the best proxy for the effectiveness of contractual control.[154]

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versy with Koza and colleagues is well documented [cf. (Reuer and Koza 2000a), (Hennart and Reddy 2000), and (Reuer and Koza 2000b)].
Similarly (Simonin 1999) shows that alliance experience and duration reduce causal ambiguity. While knowledge tacitness remains an impediment to inter-organizational learning regardless of prior experience, less experienced firms also suffer from knowledge specificity and cultural distance.

153 Note that the equity-based governance perspective rooted in TCE represents structural control. While structural governance design is an ex post approach, i.e., allocating management and residual control rights in order to minimize transaction (or agency) costs, incentive schemes, signaling, and screening mechanisms aim to ex ante preclude the costs of inefficiency.

154 Moreover, contracts may provide a road-map for alliance management and activities, extending far beyond provisions enforceable in a court of law [cf. (Ryall and Sampson 2003), (Doz 1996), (Ring and Van de Ven 1994)].

In addition to the diversity of provisions, the effectiveness of contracts may be affected by their clarity of specification [(Borys and Jemison 1989)] as well as the inclusion of contractual flexibilities [(Elfenbein and Lerner 2004)].

Empirically, (Parkhe 1993b) shows that both the perceived threat of opportunistic partner behavior and the payoffs from unilateral cooperative behavior favor the use of contractual safeguards. It may thus be systematically linked to information asymmetries and the potential losses from them: First, (Robinson and Stuart 2002) and (Lerner and Merges 1998) find project stage positively and partner firm size negatively related to the use of contractual control mechanisms. While early-stage agreements generally are subject to greater information asymmetries, partner firm size coincides with publicly available information. Furthermore, (Robinson and Stuart 2002) observe that network centrality is negatively related to contractual completeness, suggesting that the need contractual control may lower in the presence of external signals of firm quality.[155]

Second, the potential losses due to expropriation may be highest for strategically vital, since their failure might even endanger the parent firm [(Singh and Mitchell 1996)]. Accordingly, (Reuer and Ariño 2002) find strategic importance and specific investments leading to more extensive contractual safeguards.[156] (Robinson and Stuart 2002) observe that the overall value of an alliance as well as the money committed in equity investments and upfront payments increase the information content of alliance contracts. Both of these findings support the notion that the magnitude of payoffs at risk induces a need for more extensive contractual safeguards.

The explicitness of contractual provisions is related to similar factors as their extensiveness. (Robinson and Stuart 2002) observe that the degree to which each partner's contributions are specified depends on the extent and importance of information asymmetries. Similarly, (Reuer and Ariño 2002) find confidentiality, termination, and arbitration clauses more explicitly

[155] In addition, the relative bargaining power of collaborating parties may affect the extent of contractual control. For instance, (Lerner and Merges 1998) observe 'seller' firm's external access to capital (proxied by the total amount of equity raised) reducing the extent of control rights granted to the 'buyer' firms. That is, better outside alternatives allow firms to negotiate more favorable contractual terms. Also see FN 109 with regard to the determinants of bargaining power in collaborative ventures.

[156] The findings by (Reuer and Ariño 2002) indicate that strategic importance or asset specificity increase the need for explicit confidentiality, termination, and arbitration clauses, but not more extensive monitoring and other control rights (including reporting, notification, and auditing rights).

specified in strategically important alliances involving specific investments. Furthermore, some provisions may mostly be in particular collaborative settings. For instance, (Ryall and Sampson 2003) indicate that cross-border alliances require more explicit specification of development objectives and intellectual property rights. Similarly, (Robinson and Stuart 2002) find specific termination provisions significantly more often included in later-stage alliances and longer-duration contracts.[157]

Proposition 4.3a:	If information asymmetries create economically important expropriation risks, full collaborative value creation and appropriation requires more extensive and explicitly specified alliance contracts.

While the level of expropriation risk thus affects the extent and explicitness of contractual safeguards, environmental influences may reduce their usefulness. In particular, environmental uncertainty may render explicit control ineffective due to incomplete contract specification. (Luo and Tan 2003) empirically demonstrate that dynamic and complex environments reduce the specificity of contractual provisions.[158] Under dynamic, complex, and hostile market environments contingent control rights may be much effective. In addition to monitoring and control rights, these include contractual flexibilities and state-contingent control rights. These allow renegotiation or termination depending on the achievement of pre-set targets. (Elfenbein and Lerner 2004) provide evidence of market-segment maturity reducing the usage of (both technical and market-related) contingency clauses in internet-portal alliances. Similarly, (Luo and Tan 2003) document that contractual contingencies significantly increase financial and market performance under dynamic, complex, and hostile environmental conditions.

Additionally, the use of contractual contingencies may be related to information asymmetries Along those lines, (Luo and Tan 2003) observe cultural distance between partners as increasing contractual contingency.

157 Conversely, (Reuer and Ariño 2002) observe time-bounded alliances more specifically including termination clauses. Therefore, planning for the eventual end of a collaborative venture may be a more important issue when duration is non-standard, since termination is either immanent (fixed-term) or unwanted (long-term).

158 Similarly, (Ryall and Sampson 2003) posit that "next generation" (as opposed to incremental) technology alliances are associated with less extensive and complete contracts. As the development of 'next-generation' technologies is associated with substantial technological uncertainty, explicit contractual provisions may not be applicable in this context.

Similarly, (Elfenbein and Lerner 2004) show contracts employing substantially more contingent control rights when also using exclusiveness provisions, which may be indicative of incongruent incentives. Finally, (Reuer and Ariño 2002) find that limited contract duration allows to reduce the scope of monitoring and control rights (but not other contractual provisions), which suggests time-limitedness may substitute for direct monitoring, similar to the staged-investment approach used by venture-capital firms.

In all, evidence suggests that information asymmetries generally constitute the need for contractual control, whereas environmental uncertainty is the most specific determinant regarding the use of contingent control rights.

Proposition 4.3b:	Environmental uncertainty may render explicit contractual provisions ineffective and require the use of contingent control rights to assure value appropriation.

(Endogenous) Trust in Alliance Formation

Trust represents collaborating firms' belief in partner goodwill and reliability [(Ring and Van de Ven 1992)]. While the determinants of trust may be manifold, an important feature of corporate collaboration is that they endogenously produce trust.[159] In particular, trust may arise from both the prospect of ongoing collaboration as well as a history of cooperation.

First, trust may be based on the economic reasoning of long-term benefits of collaboration outweighing the short-term benefits of defection, i.e. the 'shadow of the future' [cf. (Parkhe 1993b)]. In particular, (Axelrod 1984) showed that repeated interactions of the prisoners' dilemma may allow mutual collaboration if the number of games is infinite (or unknown). A stable pattern of reciprocal cooperation may result, although either player would have a short-term incentive to defect.[160] In support of the

159 More generally, (Kautonen 2005) distinguishes endogenous and exogenous determinants. The latter including reputation effects, intermediaries, and institutions. In the present study, some of these factors were already considered in the assessment of social capital, information asymmetries and contractual safeguards. Therefore, this subsection focuses on the endogeneous developmen of trust in collaborative relations.
For more extensive work on the concept of trust, see (Kautonen 2005), (Ariño et al. 2001), and (Argandoña 1999), among others.

160 In the bargaining experiments conducted by (Axelrod 1984), a strategy combining initial cooperative behavior with retaliation for uncooperative partner behavior, 'Tit for Tat', outperformed alternative approaches. Alternative solu-

'shadow of the future' effect, (Rokkan et al. 2003) show the time horizon of an interorganizational relationship to be negatively associated with perceived opportunism. Similarly, (Ryall and Sampson 2003) find the person of the alliance manager being less often explicitly specified in alliances involving joint marketing and joint manufacturing in addition to R&D, which may be reflect continuing collaboration even after R&D has been completed. (Zucker et al. 1995) provide evidence of biotechnology researchers preferring collaboration with other scientists in the same organizations, where future interactions are inescapable.[161]

Second, trust may evolve over the course of a relationship, as information asymmetries decrease and mutual confidence increases. Along those lines, (Parkhe 1993b) shows that cooperative history (i.e., the existence of prior linkages between the partnering entities) to significantly reduce the perceived threat of opportunism. (Levinthal and Fichman 1988) posit that the likelihood of engaging with certain potential partners increases with prior relations. In their study of licensing contracts, (Anand and Khanna 2000b) find that related parties are preferred as licensors under conditions of high expropriation risks (i.e., weak intellectual property protection and cross-border licensing).[162] Similarly, (Gulati 1995a) and (Gulati and Singh 1998) show repeated transactions (i.e., between firms already having established cooperative ventures) to significantly more often take the form of contractual relation rather than JV or minority investment.[163] (Robinson and Stuart 2002) extend this evidence to shared third-party ties.

While the preceding findings indicate that prior relations may substitute for restrictive governance schemes, their substantive benefits may be lim-

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tion mechanisms to the prisoners' dilemma include the enforcement of truthful signals, e.g., documented by (Arend 2005).

161 While this evidence may equally reflect third-party enforcement (e.g., by management), (Zucker et al. 1995) argue that the 'shadow of future' is at least partially responsible for the observed pattern of collaboration. This effect is particularly relevant for high-quality research, i.e., the particularly valuable intellectual capital.

162 At the same time, (Anand and Khanna 2000b) show parties without prior relations more frequently choosing cross-licensing agreements. In lack of a trustful relationship, they may thus rely on reciprocal commitments. Similarly, licensing in the electronics industry (i.e., low intellectual protection compared to pharmaceutical industry) and (ex ante) licenses referring to technologies still under development also more often take the form of cross-licenses.

163 However, (Gulati 1995a) only observes a significant effect for equity ties. Moreover, (Oxley and Sampson 2004) and (Sampson 2004a) do not find an effect of prior alliances with collaboration partners (or overall collaborative experience) on the choice of joint ventures over contractual arrangements.

ited. (Saxton 1997) finds that alliances between firms with prior relationships (including customer/supplier relations) yield higher initial satisfaction levels but not better assessments of long-term performance. Similarly, (Robinson and Stuart 2002) do not observe a significant effect on the cash pledged to the alliance partner. The advantages of prior relations may thus primarily pertain to the alliance formation process, i.e., be facilitative in nature.

Overall, the 'shadow of the future' and prior ties appear to create trust and confidence, which in return affects the choice of collaboration partners and collaborative governance.

Proposition 4.4a:	Trust arising from long contract duration and prior interactions allows realizing collaborative value without resorting to costly governance schemes.

Trust may complement or substitute other governance mechanisms to create the level of confidence necessary for alliance formation in spite of information asymmetries. (Ring and Van de Ven 1994) and (Madhok 1995) view trust and control as alternative mechanisms, i.e., having a substitutive relationship. Conversely, (Das and Teng 1998) argue that trust and control are bilaterally interrelated and complementary.

Empirically, (Parkhe 1993b) does not observe a significant effect of transaction frequency on contractual safeguards. Similarly, (Reuer and Ariño 2002) observe that prior ties between contracting parties do not significantly influence contractual heterogeneity and extra-alliance commitments (such as confidentiality, termination, arbitration). However, such prior relations significantly reduce the scope of monitoring and control rights. Inter-partner trust consequently may not substitute for explicit contract specification, but it may reduce the need for ongoing control.

(Ryall and Sampson 2003) find that ongoing (concurrent) alliances with the same partner reduce the completeness of alliance contracts, which supports the substitutive view. If prior relations have ceased, however, contracts are significantly more elaborate. The latter points towards partners having collaborated previously knowing more specifically, which provisions to include in alliance contracts.[164] (Poppo and Zenger 2002) observe relational governance and contractual complexity to reciprocally affect and complement each other, i.e., better partner relations coincides with greater

164 (Ryall and Sampson 2003) also observe greater contractual completeness for firms with extensive overall alliance experience, i.e., irrespective of the specific partner, which may indicate that firms learn to devise effective alliance contracts.

contract complexity.[165] Similarly, (Luo and Tan 2003) suggest that 'goal congruity' has a significantly positive effect on contractual completeness, specificity, and contingencies. These findings suggest that trustful relations may allow collaborators to agree on appropriate contractual provisions.

Proposition 4.4b:	Inter-partner trust may assure value appropriation through better specified contractual statutes and a reduced need for ongoing monitoring and control.

Other Mechanisms for Reducing Information Asymmetries (Exogenous Sources of Trust)

As patents may render assets fully appropriable by the patent owner, patent protection may reduce the risk of knowledge expropriation and thus facilitate collaboration.[166] Most generally, (Hagedoorn and Schakenraad 1994) encounter significantly higher partnering rates for patent-intensive industries.[167] More generally, (Oxley 1999) and (Sampson 2004a) document that the effectiveness of intellectual property rights (as well as judicial efficiency, rule of law, and (low) political risk) is negatively related to the choice of EJVs over contractual alliances. (Subramanian 2004) shows that collaboration in high patent protection industries benefit from cooperative behavior and more extensive technology sharing without extensive hierarchical controls. (Anand and Khanna 2000b) observe fewer licenses granted in cases of weak protection schemes and exclusive licenses most common in chemical and pharmaceutical industries, where intellectual protection is

[165] Based on survey data, (Poppo and Zenger 2002) measure relational governance as incorporating communication, trust, and cooperation among partners. Similarly, contractual complexity refers to the degree of customization and legal detail. In a three-stage simultaneous equation (GLS) specification, both constructs exert distinctly positive effects on alliance performance.

[166] Note that this is in contrary to the spillover internalization hypothesis above [subsection 2.2.1.2], which argued that the inadequate investment incentives associated with insufficient innovation appropriability necessitates collaboration.

[167] Similarly, (Gulati and Singh 1998) find automotive and new materials firms to establish more joint ventures or use minority investments compared to more contractual relations in the pharmaceuticals industry. That is, relatively weak property rights encourage automobile firms to utilize joint ventures and equity linkages to reduce agency costs. Additionally, (Gulati and Singh 1998) document a significantly positive interaction effect of R&D alliances in the automotive industry.

strongest.[168] All in all, research has thus demonstrated that effective patent protection significantly reduces the need for restrictive transaction governance.

With regard to specific patent characteristics, (Subramanian 2004) exhibits the generality of a firm's patent portfolio to reduce the propensity of hierarchical control as well as the extent of technology access. That is, patents applicable in a wide range of domains may be less expropriable despite limiting the explicit access to these technologies. However, the effects of patent protection and generality are not fully additive, since both factors interact in favor of hierarchical control.[169] Patent generality thus may primarily reduce the need for patent protection.

Generally, evidence supports the view of patent protection reducing expropriation risks and instilling confidence in alliance partners.

Proposition 4.5:	Effective patent protection may enable the appropriation of collaborative value without incurring the costs of more restrictive governance.

2.4 A Dynamic Theory of Cooperative Value Creation

2.4.1 Background and Value-Creating Mechanism

This chapter has so far considered various sources of strategic collaborative benefits (subchapter 2.2) as well as reasons for alliances being efficient organizational structures (subchapter 2.3). Both represent necessary antecedents of collaborative value creation. However, they can only sufficiently explain this phenomenon, if they adequately reflect the benefits and costs of collaboration over the long term.

Indeed, many of the approaches discussed above include references to the time dimension of collaborative activity. For instance, the strategic objectives of market power, entry, and competitive advantages are based on the idea of achieving a future value-maximizing state. Similarly, the no-

168 Conversely, (Hagedoorn and Duysters 2002a) fail to show a significant effect of a firm's patenting intensity (relative to the industry average) on the choice of cooperative or acquisitive transactions.

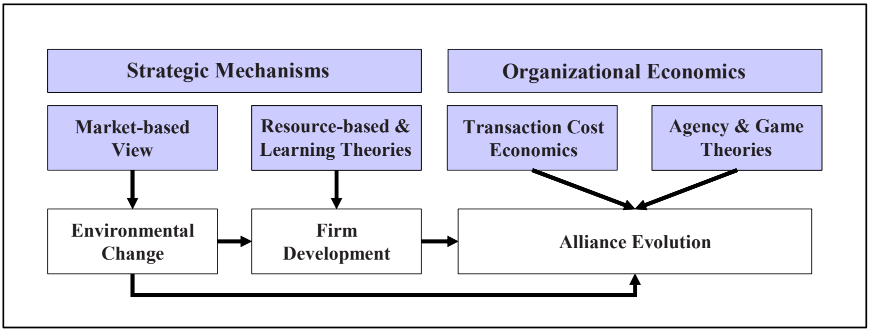
169 At the same time, patent protection and generality interact to further broaden technology access [(Subramanian 2004)], indicating that patent protection allows alliances to extend to the entire patent scope. Note that these findings also are cosistent with the notion that transaction scope and governance are mutually related [see subsection 2.3.1.2, in particular proposition 3.3].

tions of trust and social capital are inherently time-dependent, since they link prior behavior (e.g., alliance formation) to current behavior and results (i.e., alliance formation and performance). Moreover, the learning perspective and the transaction cost rationale essentially address post-formation behavior.

Given that the present study focusses on dynamic drivers of collaborative value (Objective 3, section 1.2.1), this section more explicitly considers dynamic extensions of the general alliance-related theories. This relates to all factors reflecting changes in the net benefits of alliances over time:

- The market-based view (section 2.2.1) posited that collaboration improves firms' competitive positioning and rectifies suboptimal R&D incentives. Environmental change alters the status quo and therefore the benefits of collaborative ties. At an aggregate level, industry dynamics determine the value of firms' alliance portfolios and positioning in alliance networks. While corporate strategy views alliances as tools to achieve competitive advantages, the above alliance-related evidence does not account for changes in firm's environment, which may affect the value of collaborative activities.
- The resource-based view (section 2.2.2) argued that focal and partner firm resources form the basis of collaborative benefits. The evolution of firms' internal resource bases (firm development) affects the value of resources accessed through alliances. While the RBV generally mandates resource complementarity, it does not address systematic changes in resource needs arising from firm development. Neither does it explicitly examine the role alliances play in fostering firm development.
- The organizational economics approaches highlighted that alliances may be optimal organizational modes under specific environmental conditions (transaction cost economics, section 2.3.1), but need to consider the stability of inter-partner relations (agency theory, section 2.3.2). This implies that a collaborative relationship may change over its course. However, standard organizational economics do not consider the evolution of collaborative value along an alliance's developmental path.

Figure 12: Dynamic Extensions of Fundamental Theories



Source: Own Illustration

As illustrated in Figure 12, the present section addresses the dynamic extensions of these fundamental theories. They have common that they consider the value of a collaborative venture depends on its congruence with changing environment conditions.[170] Such dynamics may refer to conditions outside the firm (e.g., market competition, technological development), within the firm (e.g., changing resource endowments and needs), or pertaining to the alliance itself (e.g., partner relations, alliance performance).

The actual mechanisms of dynamic collaborative value creation may differ: On the one hand, strategic alliances may enhance corporate value by helping firms adapt to new (environmental or firm-level) requirements. Alliances thus may serve to facilitate evolutionary processes and allow firms to continually stay abreast of their competition.[171] On the other hand, alliances are inherently flexible and may present opportunities for future adap-

170 More generally, the viability of any organization is determined by its ability to withstand market selection. This general notion of economic evolution forms the theoretical basis for any dynamic perspective Table 48 in the appendix provides an overview of the general concept. (Van de Ven and Poole 1995) and (Von Schroeter 2004) provide more extensive overviews of relevant theories.

171 In their seminal work on dynamic firm capabilities, (Teece et al. 1997) suggest that long-term market success can only be reached by continually developing new forms of competitive advantage. Processes of learning, reconfiguration, and transformation are essential antecedents of such adaptation. In particular, the firm's ability to evaluate its market environment, anticipate and fulfill the need for reconfiguration is such a dynamic capability. As these routines are tacit and hardly observable, they are difficult to replicate internally, let alone imitate externally. Alliances may be part of such routines.

tation. That is, they may position firms to react to future developments without requiring full engagement in downside risks.[172]

Overall, firms thus may enter into alliances to provide flexibilities and realize the value of these flexibilities for adaptive purposes.

Reasoning 5:	Alliances create firm value by generating and exercising strategic flexibilities under conditions of dynamic external environments, changing organizational requirements, and endogenous alliance evolution.

2.4.2 Dynamic Collaborative Benefits

The present section details the dynamic properties of strategic alliances and collaborative benefits. In sequence, it considers the effects of environmental dynamics (subsection 2.4.2.3), firm development (subsection 2.4.2.1) and alliance evolution (subsection 2.4.2.2).

2.4.2.1 Implications of Environmental Dynamics

Environmental change induces firms to adapt in order to remain profitable and survive. In the short term, it requires firms to reconsider their current positioning. For the long term, it implies a need to take precautionary measures in anticipation of further change. Both of these aspects are important in a collaborative context.

Pressure to (Re)Structure Alliance Network

Different environmental conditions may require specific forms of organization [cf. (Hannan and Freeman 1989)]. This is reflected in the fact that different industry exhibit varying levels and types of alliance activity [cf. (Cairnarca et al. 1992)].[173] The resulting industry-specific network struc-

[172] While real-option theory is not the explicit focus of the present section, this coincides with the three basic characteristics of real options: uncertainty, flexibility, and irreversibility (see Table 49 of the appendix for details). Consequently, several authors have referred to collaborative ventures as real options [e.g., (Folta and Miller 2002), (Vassolo et al. 2004)] For a recent review of real-option theory, see (Baecker and Hommel 2004).

[173] (Davenport and Miller 2000) summarize that the dominant motive and mode of technology alliances differ with the sector and life-cycle stage. Specifically, firms in "mature" industries form (non-equity) alliances to influence demand and control market structure. Contrarily, firms in emerging industries ally to

tures represent an evolutionary reaction to the specific requirements each setting [(Nelson and Winter 1982)]. Therefore, being entrenched in an industry network should be associated with strategic benefits, i.e., firms in the center of a network may have optimally positioned themselves under the given conditions.[174] Along those lines, (Gulati et al. 2000) argue that firm performance may be substantially hurt by being excluded from the advantages of membership in core industry networks (lock-out effect).

With regard to the process of network establishment, (Doz et al. 2000) suggest that networks of interorganizational relations emerge in response to perceived interdependence among firms, who react by pursuing their common interests through collaborative ventures.[175] The most prominent examples of collaboration networks forming in response to strong exogenous influences were the Western automobile industry faced with increased Japanese competition [cf. (Nohria and Garcia-Pont 1991)] and the global pharmaceutical industry in the wake of the 'biotechnological revolution' [(Zucker and Darby 1995)]. On a more continuous level, (Link et al. 2001) observe that business cycles and the national competitive position in high-technology industries are negatively related to the establishment of research joint ventures. Similarly, (Burgers et al. 1993) show that firms with declining market shares enter into a greater number of alliances.

All these findings point towards environmental change inducing network formation. In particular, eroding market prospects create incentives to seek network benefits. This suggests that alliances may help firms overcome the effects of adverse environmental change.

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combine human and technological resources (using equity). (Sydow and Windeler 1998) provide different examples.

174 (Nohria and Garcia-Pont 1991) provide evidence that interorganizational relations even may evolve into competitive constellations (i.e., strategic blocks) providing all associated firms with access to a similar range of capabilities, i.e., the strategic blocks themselves may become the competitors in an industry.

175 Specifically, interdependent firms recognize their similar interests and find it not overly difficult to reach consensus regarding the domain of collaboration, resulting in network structures, perceived as desirable by their members (as reflected in relatively long expected network membership).
Alternative to an emergent process, networks may be proactively engineered by a triggering entity. Specifically, (Doz et al. 2000) find the existence of a triggering entity negatively related to environmental interdependence, suggesting that engineered processes will be resorted to if environmental pressure for collaboration is insufficient. In this context, (Koza and Lewin 1998) refer to intentional or rational network creation.

Proposition 5.1a:	Alliances create firm value by positioning firms in industry networks, which may alleviate competitive disadvantages and unfavorable environmental conditions.

Environmental change may equally affect the structural integrity of existing networks. (Madhavan et al. 1998) propose the distinction of structure-reinforcing and structure-loosening events, depending on whether they strengthen or alter an industry's basis of competition.[176] In this context, (Duysters et al. 2002) suggest that firms deeply entrenched in collaborative networks may be better positioned to benefit from incremental developments, whereas their innovativeness may be hampered by over-embeddedness under conditions of radical technological change.[177] (Burkhardt and Brass 1990) find that, pursuant to technological shifts, early adopters of novel technologies increased their centrality in industry networks compared to later adopters. Similarly, the prior network structure was strengthened (i.e., reinforced) if the early adopters already were centrally located. Technological development thus may provide an opportunity for innovators to more prominently position themselves in industry networks and may threaten embedded incumbents.

In the face of environmental change, it may thus be prerogative to collaborate in order to maintain valuable network positions. Firms not participating in the process of network reconfiguration may be at a disadvantage. Along those lines, (Silverman and Baum 2002) show that the formation of horizontal and some forms of vertical alliances increases the likelihood of market exit for excluded rivals.[178] As a result, firms may even enter alli-

[176] For the global steel industry, (Madhavan et al. 1998) observe a reinforcement of network structure following a regulatory event facilitating collaboration without affecting the underlying bases of competition. For a technological event providing increased opportunity for market competition, however, they exhibit a significant modification of network structure.

[177] The concept of over-embeddedness goes back to (Uzzi 1997). (Gulati et al. 2000) propose alliance exclusiveness and 'partner fidelity' as the main determinants of such lock-in effects. Moreover, incumbent firms may be less able to accommodate technological changes For instance, (Zucker and Darby 1995) document such difficulties for big pharmaceutical firms faced with the 'drastic' innovations associated with the biotechnological revolution. (Henderson and Clark 1990) make a similar argument with regard to 'non-drastic' reconfigurations of exiting products.

[178] The magnitude of these effects suggests that the increase in competitive pressure due to being excluded from collaboration is the driving force behind these market exits. (Silverman and Baum 2002) also find additional horizontal alliances by rivals tied to the focal firm by a prior alliance as having this ef-

ances for the sake of belonging to the network irrespective of other immediate gains [cf. (Park and Zhou 2005)]. Concurrently, (Park et al. 2002) find that the overall number of alliances in an industry to have a positive effect on alliance formation.[179]

In total, these findings indicate that collaborative benefit increase, when environmental change requires network adaptation.[180]

Proposition 5.1b:	Alliances create firm value by helping firms reach or maintain favorable positions in reconfiguring networks.

Need for Flexibility

Since over-embeddedness may be a constraint in the face of revolutionary technological change, it may have adverse effects under conditions of high environmental uncertainty. The danger of being locked into a specific network position may, however, be mitigated through diversification of linkages. Diverse partners and types of relations provide firms with the flexibility to reprioritize their alliances in their depending exogenous developments.

Alliance portfolios thus represent bundles of distinct strategic options.[181] For R&D alliances, (Vassolo et al. 2004) refer to these as options on the highest of two asset values. Similarly, (Zucker and Darby 1995) suggest that flexibilities not only refer to switching among different collaboration projects, but also to learning whether to build up certain capabilities internally (option to stage invest). (Duysters and de Man 2003) even argue that

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fect. That is, the disadvantage of being excluded from horizontal alliances dominates any benefits of prior involvement. Contrarily, vertical alliances of such ‘coopetitors’ reduce the firm drop-out rate. This suggests that firms may profit from second-hand knowledge spillovers.

179 Note that the effect observed by (Park et al. 2002) becomes insignificant (while maintaining its positive sign) if the interaction terms of internal resources and market demand changes are entered, which may reflect endogeneity, since the aggregate alliance decisions are strongly driven by the existing resource bases and market uncertainties.

180 Alternatively, such findings may reflect (at least some) firms mimicking successful competitors’ actions, a phenomenon dubbed ‘mimetic isomorphism’ by (DiMaggio and Powell 1983). This would imply that firms follow prescribed patterns regardless of their economic rationality. Also see subsection 2.3.1.3 and FN 142 on mimetic behavior in the choice of organizational modes of international market entry.

181 More generally, (Williamson 1999b) refers to creating a portfolio of strategic options as the overall objective of corporate strategy, since they allow to opportunistically exercise those turning out to be most attractive.

transitory alliances, i.e., collaboration focusing on narrowly defined tasks and ex ante intended to be of short duration, may be specifically entered for such purposes.

Under conditions of uncertainty, the value of flexibilities inherent in strategic alliances increases. In particular, the volatility of potential gains renders it beneficial not to irreversibly commit resources.[182] Along those lines, (Harrigan 1988a) highlights the importance of demand and competitive uncertainty for the frequency of collaboration. (Park et al. 2002) also link the change in market demand to increased alliance formation, albeit at a marginally decreasing rate. (Dickinson and Weaver 1997) find general environmental uncertainty as well as changing technological and demand conditions positively related to the use of alliances.[183] Similarly, (Gersony 1996) and (Eisenhardt and Schoonhoven 1996) observe that alliance activity is greater in emerging-stage industries than in technologically more settled domains. Finally, (Sarkar et al. 2001) suggest that pursuing collaborative flexibilities in uncertain environments of may enhance firm performance.[184] Similarly, (Hagedoorn and Duysters 2002b) provide evidence of many, seemingly redundant alliances increasing performance in the computer industry.

The presented evidence supports the view that environmental uncertainty increases the frequency and potential benefits collaboration. In particular, collaborative flexibilities may position firms for future environ-

182 This notion is in line with evidence that uncertainty shifts governance-mode choice from proprietary (e.g., mergers and/or acquisitions) towards collaborative [see subsection 2.3.1.2 for details]. These findings even more strongly support the flexibility value argument, since they are contrary to transaction-cost reasoning.

183 Additionally, (Dickinson and Weaver 1997) suggest that these effects may be moderated by management characteristics. In particular, entrepreneurial orientation and individualistic cultural traits reduce the propensity of managers to employ collaborative flexibilities. While not significant explanatory variables by themselves, they negative interact with uncertainty and positively with the firm's internal growth potential, suggesting that these firms prefer 'putting all eggs into one basket'.

184 Specifically, (Sarkar et al. 2001) find the interaction of uncertain or rapidly changing demand conditions and alliance proactiveness to have a positive impact on market success. Conversely, uncertainty regarding technological advances and competitive action do not increase the benefits of proactive alliance formation.

mental change and allow them to profit from arising market opportunities.[185]

Proposition 5.2:	Alliances create firm value by providing strategic flexibility, in particular under conditions of high environmental uncertainty.

2.4.2.2 Effects of Firm Development on Alliance Activity

Diverse evidence has documented effects of collaborative activity on firm development, using indicators such as patenting, new product introductions, sales growth, and firm survival [see subchapters 2.2 and 2.3]. At the same time, progression along a firm's developmental path may also affect its incentives to collaborate. In particular, (Koza and Lewin 1998) suggest that the strategic intent of alliance may co-evolve with changes in corporate strategy, managerial preferences or the organizational environment. This section addresses the influences of firm development on the relevance of collaborative activity in general and on the benefits from specific types of alliances.

Relevance of Alliance

Alliances appear to most benefit firms lacking certain capabilities (such as an existing market presence, cf. subsection 2.2.1.3) or resources (such as technological or commercial capital, cf. subsection 2.2.2.2). More generally, young and small firms may draw on collaborative ventures to further their development.

Prior evidence supports this notion. For instance, (Shan 1990) shows that smaller firms are more likely choosing alliances over proprietary commercialization strategies.[186] Similarly, (Sarkar et al. 2001) find the

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[185] Environmental uncertainty may also affect less obvious sources of collaborative value. For instance, (Chung et al. 2000) find that the effect of social capital (prior direct and indirect ties) on alliance formation is stronger in situations of greater uncertainty. In particular, investment banks collaborate more often on (high uncertainty) IPOs than on (low uncertainty) secondary public offerings. This suggests that trust developed through prior contacts facilitates collaboration under adverse environmental conditions.

[186] Studies on alliance motives also support the general notion of small firms allying to promote their development. Specifically, (Glaister/Buckley 1996) document that technology development and product diversification are more important motives for smaller firms. Similarly, (Hagedoorn 1993) shows technological complementarity and reduced lead times to be of greater importance

positive association between alliance proactiveness and firm performance being negatively moderated by firm size, i.e., smaller firms may stand to gain more from proactively pursuing alliance opportunities. (Oliver 2001) even provides evidence linking a lack of strategic alliances to organizational death for young biotechnology firms.

While younger, smaller firms thus may profit from accessing more established partners' resources, the value attributed to partner resources may decline once certain resources are available internally. Along those lines, Stuart (2000) observes a significantly negative interaction effect of focal firm age and sales with partner sales. That is, the commercial capital contributed by cooperation partners becomes less valuable as firms mature and develop such resources themselves. Concurrently, (Park et al. 2002) show that focal firms' technological diversity and internal manufacturing capabilities reduce the incentive effects of growing market environments on alliance formation.[187] The adverse effect of firm development on collaborative benefits thus can be traced to its specific resource endowment.

The interrelation of firm development and alliance activity may, however, be more complex. In particular, collaborative benefits may underlie a cyclical pattern. For instance, (Oliver 2001) shows that the number of alliances formed by young biotechnology at first steeply increases with age and then declines as they mature.[188] Similarly, (Niosi 2003), while identifying alliances as the most important driver biotechnology firms' growth, also observes a significant direct effect of firm age. These findings suggest that developing firms may profit from collaborative learning, but may require periods of internalization to fully realize those benefits. In particular, (Vanhaverbeke et al. 2004) demonstrate that collaborative links more

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for high-technology firms, which tend to be younger and smaller than firms in more established markets.

187 That is, firms which have developed internal resources rely less on collaboration to satisfy increasing demand, unless market growth is particularly explosive. Technically, the interaction effects of technological diversity and manufacturing facilities with linear market growth are significantly negative, those with the quadratic term are positive. Conversely, the interaction of financial resources with market demand changes are not significant.
Somewhat contrarily, Stuart (2000) observes the relevance of partners' technological resources less pronounced for younger firms as well as firms with larger prior sales.

188 Specifically, the firms studied by (Oliver 2001) experience high collaboration rates between their 2nd and 8th/9th year of existence. Moreover, evidence suggests that collaboration intensity may rise again for firms aged 13 and over. As (Oliver 2001) notes, such an 10-year cycle of alliance activity would roughly coincide with the development life-cycle for biotechnological drugs.

strongly help firms broadening their technological base than strengthening their core technologies.[189] That is, once established through collaboration, technological capabilities may need to be augmented internally.

All in all, firm development systematically appears to reduce collaborative benefits, although this effect may not be monotonous. In particular, the access to partner firm resources becomes less attractive as firms develop sufficient resources internally.

Proposition 5.3:	The value of strategic alliances is smaller for further developed firms.

Developmental Value of Alliances

With regard to corporate development, alliances may target the exploration of new opportunities or the exploitation of existing capabilities [cf. (Koza and Lewin 1998), (March 1991)]. While exploitation alliances allow to realize immediate tangible benefits, collaborative exploration may be required to build up internal capabilities and to ensure long-term organizational viability [cf. (Levinthal and March 1993)]. The relative value impact of each alliance type may hinge on organizational needs, which in return depend on firm development. In particular, three phases of development may be relevant: Start-ups, developing, and mature firms.

First, start-up firms may require exploration alliances to accumulate the technological competency required to complete their process of establishment. In addition to fostering the collaborators resource bases, (Rothaermel and Deeds 2004) show that exploration alliances are prerequisite for the formation of exploitation alliances.[190] An important function of exploration

[189] (Vanhaverbeke et al. 2004) distinguish patent classes in which firms have (not) previously received patents (over a 5-year period). Both direct and indirect links more strongly support innovation (i.e., patenting) in new classes than those previously established.

[190] More specifically, (Rothaermel and Deeds 2004) posit that alliances targeting exploration and exploitation are core components of an integrated product-development path. In their empirical analysis, they observe exploration alliances significantly increasing the firms' number of products in development, which in return increase the likelihood of entering into exploitation alliances, which finally increase the number of marketed products.

Note that (Rothaermel and Deeds 2004) also document significant influences of firm age and size on products under development, exploitation alliances, and marketed products. However, since they neither can include interaction effects in their LISREL model nor address the determinants of exploration alliance formation, the interaction of organizational and alliance-based development cannot be comprehensively assessed.

alliances thus is to pave the way for further collaboration. (Powell et al. 1996) substantiate this argument with regard to R&D alliances.[191] Consequently, exploration alliances allow start-ups to grow their internal resources bases and facilitate further collaboration, while exploitation alliances are not yet available to them.

Second, developing firms having compiled internal capabilities may benefit from leveraging them through exploitation alliances, which may provide benefits more directly related to the operating and financial performance than exploration alliances. Consequently, (Rothaermel 2001) finds exploitation alliances having a positive (although marginally decreasing) effect on new product development. Similarly, (Baum and Silverman 2004) observe that downstream alliances have a significant impact on the revenues and private equity raised by Canadian biotechnology firms. Conversely, exploration [(Rothaermel 2001)] and upstream [(Baum and Silverman 2004)] alliances have no such effects.

Third, larger established firms may possess sufficient internal capabilities to exploit its capabilities in isolation, reducing the benefits of exploitation alliances. Along these lines, (Rothaermel 2001) observes that the increased levels of new product introductions derived from exploitation alliances negatively interacts with firm age. Similarly, (Wilson and Appiah-Kubi 2002) find that older firms heavily relying on vertical relations experience lower profit growth than similar firms without such networks.[192]

In all, as the needs of firms evolve, the relative benefits of different alliances may change. In particular, exploitation alliances hold the greatest potential advantages for established, but still developing firms. Conversely, collaborative exploration most benefits start-ups and mature firms, as they try to establish themselves or to overcome organizational inertia, respectively.

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[191] Similarly, (George et al. 2002) show that alliances with universities significantly increase the number of (other) alliances formed by biotechnology firms. University alliances thus may provide the technological resources and signals of technological competence prerequisite for additional cooperative ventures.

[192] This evidence may be somewhat misleading, since (Baum and Silverman 2004) only study high-tech firms with an average age of 9 years. At the same time, (Baum and Silverman 2004) show that firm age per se does not discriminate profit or sales growth and that access to external resources generally has a significantly positive effect on both. While 'older' firms may thus only profit from horizontal relations, vertical network ties have a positive effect on the profit growth experienced by younger firms.

Proposition 5.4:	Alliances create firm value by contributing to the exploration and exploitation of strategic resources in line with the evolving organizational development needs of focal firms.

2.4.2.3 Individual Alliance Evolution

While industry- and firm-level influences were above primarily discussed with regard to alliance formation decisions, they also have substantial impact on existing alliances. In brief, post-formation adaptation and alliance termination may both serve to restructure and realign firms' alliance portfolios with industry conditions and corporate-level strategies. Aside from such exogenous influences, interorganizational relationships may also evolve endogenously. While the completion of initial knowledge acquisition objectives may jeopardize the continuation of an alliance [cf. subsection 2.2.2.4 on learning races], collaborative achievements may equally instill mutual trust and reinforce joint activities [cf. subsection 2.3.2.3 on the evolution of trust].

Exogenous and endogenous change (i.e., originating outside or inside the individual alliance) provides an opportunity for collaborating firms to reconsider the economic rationality (efficiency) or reciprocal benefits (equity) of an existing alliance.[193] This may in return lead to corrective action, such as revisions of firm contributions and outcome distribution (adaptation) or outright alliance termination.

In line with Reasoning 5, the possibility to modify or terminate collaboration may be valuable, since it represents the flexibility to choose the better of two outcomes at one's own discretion (long position). At the same time, the exercise of similar options by collaborating firms may negatively affect the focal firm (short position). This subsection addresses these implications of adaptation, termination, and internalization flexibilities.

Adaptation

Adaptation encompasses any modification of collaboration terms and structure, e.g., in response to changing market conditions or strategic re-

[193] For instance, (Ring and Van de Ven 1994) propose a model, which identifies alliance development as a circular process consisting of negotiations, commitments, and execution. The initial alliance conditions are the result of ex ante objectives, expectations, and negotiations leading to a preliminary commitment by the alliance partners. Earlier models, such as (Chan and Harget 1993), have a management-oriented focus but identify similar development stages.

quirements of partnering firms [cf. (Harrigan 1985), (Heide and John 1992)].[194]

As (Ariño and de la Torre 1998) point out, such actions may be unilateral or based on a mutual renegotiation of alliance terms. From the individual firm perspective, initiating, supporting, or accepting alliance modification is only rational if it yields equivalent of higher value relative to the status quo. Therefore, alliance modification should not lead to value destruction, although the benefits of adaptation may differ among collaborators. In this context, (Young-Ybarra and Wiersema 1999) suggest that post-formation flexibilities to modify alliance agreements are linked to transaction and relationship characteristics. Specifically, they find that trust, multiple collaborations, and balanced asset contributions facilitate modification. All these factors reflect a joint commitment to continued collaboration. Contrarily, alternative alliance partners, and relative power in an alliance reduce modification flexibilities.[195] Intra-alliance power and dependence thus may determine willingness to modify alliance terms.

Proposition 5.5a:	Modification of existing alliance creates collaborative value by realigning the collaboration to contextual requirements, with value appropriation depending on the collaborating firms' relative bargaining power.

[194] A variety of case-based research has attempted to document the evolution of individual alliances over time. Work by (Hamel 1991), (Ariño and de la Torre 1998), (Larsson et al. 1998), and (Davenport and Miller 2000), among others, has identified a variety of flexibilities to adapt existing relationships while continuing collaboration. With regard to joint ventures, (Reuer and Miller 1997) propose a model distinguishing within-JV ownership instability and discrete changes in JV governance. In the former case of modification, all parents remain invested, albeit with reorganized equity stakes. The latter cases encompass JV dissolution, secondary sales, as well as buyouts by parent firms.

[195] Counterintuitively, asset specificity also reduces willingness to modify. Considered together with the effect of balanced asset commitments, however, it suggests that firms will avoid modification if they are more strongly committed (possibly due to the risk of expropriation), whereas they welcome modification if that risk is offset by partners' asset commitments. (Young-Ybarra and Wiersema 1999) also provide similar evidence regarding the flexibility to exit alliances.

Termination/Dissolution

While collaboration may end due to various causes, such as the achievement of their natural end points or internalization of successful collaboration, most prior work on this issue has deemed termination to reflect failure. Conversely, alliances stability and longevity have been considered as success indicators [e.g., (Barkema et al. 1997), (Barkema and Vermeulen 1997), (Killing 1983), (Li 1995), (Park and Russo 1996), (Park and Ungson 1997)]. Indeed, unsatisfactory alliance outcomes are an empirically important determinant of alliance (in)stability. For instance, (Harrigan 1988b) and (Bleeke and Ernst 1991) observe alliance satisfaction and survival rates in the range of 40 to 50 percent, respectively.[196] Conversely, potential benefits of collaboration may instill stability. Along those lines, (Kogut 1989) observes that learning opportunities (R&D intensiveness in R&D ventures) and favorable market conditions (shipment growth) reduce the rate of JV dissolution.

In addition to collaborative (non)performance, intra-alliance rivalry may lead to alliance termination. (Kogut 1989) observes that the absolute level of industry concentration and increases therein as well as scale intensiveness (minimum efficient scale in production ventures) lead to significantly higher termination rates.[197] These findings suggest that competitive rivalry may be the source of alliance instability. Similarly, (Barkema et al. 1997) and (Barkema and Vermeulen 1997) observe that cultural differences between partners increases JV termination. Structural control may offset these risks to some extent. (Killing 1983) and (Li 1995) find that collaboration is more instable if focal firms exert majority control over collaborative ventures. Similarly, (Kogut 1989) suggests that concurrent ties among partners may stabilize a relationship. This effect is particularly strong for concurrent JVs and licensing agreements (as opposed to buyer-supplier relations).

All in all, alliance terminations appear to result when prior underperformance and intra-alliance competition outweigh the costs of dissolution

[196] (Gomes-Casseres 1987) provides evidence of IJVs being more often dissolved or sold than wholly owned subsidiaries. As both are substitute mechanisms for international market entry, IJVs may be used to learn about market conditions and the later set-up of proprietarily owned entities. (Kogut 1988c) documents lower dissolution rates for international than domestic JVs early on, whereas they peak 5 to 6 years after formation. (Das and Teng 2000a) provide an overview of earlier evidence on alliance instability.

[197] Similarly, (Kogut 1988c) observes relatively high mortality rates for marketing and after-sale service JVs as well as for service industry JVs in general. This highlights that JVs requiring comparably low investments in physical goods can be dissolved more easily, when early performance is insufficient.

and expected alliance benefits. It can therefore be considered as indicating collaborative failure.

Proposition 5.5b:	Alliance termination reduces collaborative value by eliminating collaborative benefits in reaction to insufficient performance and/or excessive rivalry among partners.

Internalization
While termination, i.e. the discontinuation, of collaborative activities may reflect failure, their internalization by one partner may be equally indicative of successful alliance progression. (Hagedoorn and Sadowski 1999) indicate that 2.6% of all contractual alliances lead to subsequent M&A transactions, which may be an economically meaningful number.[198]

The value implications of internalization depend on its relative benefits vis-à-vis continuing collaboration. In particular, by buying out alliance partners, firms exercise the flexibilities inherent in the alliance. As the flexibility (or option) value of alliances is linked to environmental uncertainty (cf. proposition 5.2 in subsection 2.4.2.1), internalization (or option exercise) may become favorable as uncertainty diminishes or the expiry of the flexibilities becomes immanent.

First, reduced environmental uncertainty makes it more appealing to trade the strategic flexibility of alliances for fully proprietary benefits. In support, (Kogut 1991) finds positive performance signals (proxied by annual growth rates and deviations from long-term growth rates) linked to venture buyouts.[199] (Folta and Miller 2002) show that firms increase their equity stakes in research partners following positive developments in sectoral stock indices, which may reflect increases in the underlying values and reductions in technological uncertainty. Conversely, (Folta and Miller 2002) observe firms less likely to expand their equity stakes, if uncertainty

[198] (Hagedoorn and Sadowski 1999) observe a higher likelihood of acquisitions for equity-based collaboration; however, the difference fails to be statistically significant. One possible explanation for this would be that firms already holding an equity stake in a target may have preferential access to value-related information.

[199] Other indicators for venture acquisitions (by one parent) include high industry concentration, which may reflect the danger of value expropriation through competitive rivalry. Furthermore, both R&D and marketing/distribution ventures are more likely to be bought out than production joint ventures.
Moreover, (Hagedoorn and Sadowski 1999) find horizontal alliances, those targeting core technologies (e.g., biotechnology, IT, new materials), and those with large partner firms being less likely to culminate in acquisitions.

is high.[200] In such cases, the flexibility value remains sufficient to render immediate exercise suboptimal.

Second, options that may be deemed secure from expiry are less likely to be immediately exercised.[201] Along those lines, (Vassolo et al. 2004) observe that firms choose to maintain their flexibility, i.e., to neither divest nor acquire, given the existence of an explicit buyout options (compared to plain minority equity stakes). Conversely, (Folta and Miller 2002) find that firms more likely increase equity stakes if other firms also hold equity in the target firm. In this case, the danger of competition for internalization reduces the value of waiting for further uncertainty resolution.

The above evidence supports the view that firms internalize collaborative ventures, when their flexibility value decreases relative to their present value. In particular, reduced environmental uncertainty and higher risks of option expiry promote internalization.

Proposition 5.5c:	Alliance internalization creates firm value by monopolizing collaborative benefits in reaction to the successful progression of activities.

2.5 Summary and Discussion of Propositions

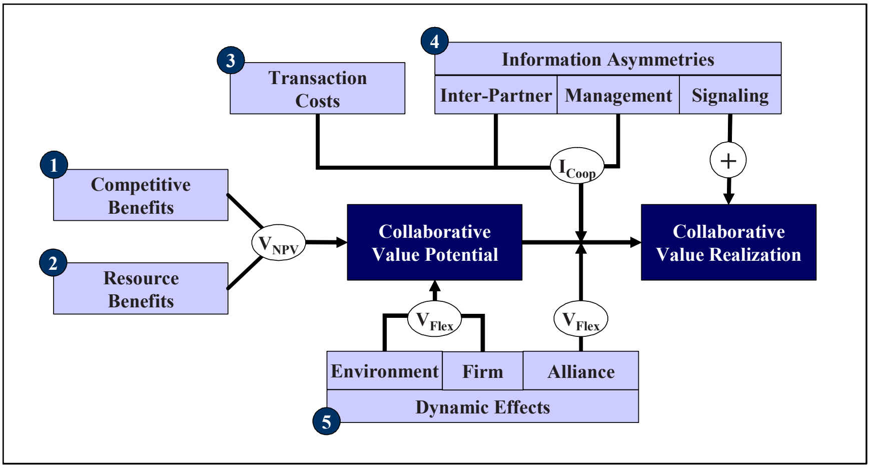
This chapter has extensively reviewed the theoretical and empirical literature relating to the formation and performance of collaborative ventures. Figure 13 presents an overview of the different influences on collaborative value identified in this chapter.[202]

200 Contrarily, (Vassolo et al. 2004) do not observe a significant effect of industry uncertainty on the likelihood of partner acquisitions. However, they find industry uncertainty reducing the likelihood of divestiture (i.e., termination). Consequently, the exercise of (call) options to acquire partners may be primarily driven by the underlying value (e.g., of technologies), but such options are at least maintained (i.e., put options not exercised) if uncertainty remains high.

201 Similarly, (Doz et al. 2000) suggest that evolving networks are viewed primarily as options by their sponsoring firms. Specifically, they find expected continuity (i.e., length of network membership) not leading to stronger involvement in R&D consortia. Note, however, that (Doz et al. 2000) regard this evidence as more specific evidence for emergent formation processes leading to consortia being regarded as options by their members.

202 Table 51 of the appendix provides a more detailed overview of the propositions derived in the present chapter.

Figure 13: Integrative Model of Collaborative Value Creation



Source: Own Illustration

Overall, five perspectives (❶ to ❺ in Figure 13) have been contrasted to provide an integrative picture of the sources and limitations of collaborative benefits. These influences differ in their mechanism of action, either by providing the basis for collaborative value creation or by affecting the realization of this potential:

- Industrial economics and strategic management (❶) approaches refer to the ability of strategic alliances to improve performance in competitive market environments. These effects include increased efficiency (e.g., through spillover internalization or economies of scale) as well as monopolistic benefits (e.g., through collusive strategies or differentiated product offerings).
- Resource-based and learning theories (❷) of strategic alliances highlight the actual objects of collaboration, i.e., the combination of firm resources. The relevant types of capital range from technological and commercial resources to social embeddedness. Additionally, collaborative competence and absorptive capacity affect the success of alliance learning.

Both competitive and resource-related effects generate the basic foundation of collaborative value. The other identified influences either moderate this potential or affect its translation into actual value creation:

- TCE (❸) explains the existence of hybrid organization as well as distinct collaborative governance structures (e.g., strategic alliances versus JVs) based on transaction and environmental characteristics. While collaborative ventures may be efficient under conditions of moderate asset specificity, environmental uncertainty, and transaction scope, transaction costs generally reduce the net benefits of collaboration vis-à-vis the unrestricted potential for collaborative value creation.

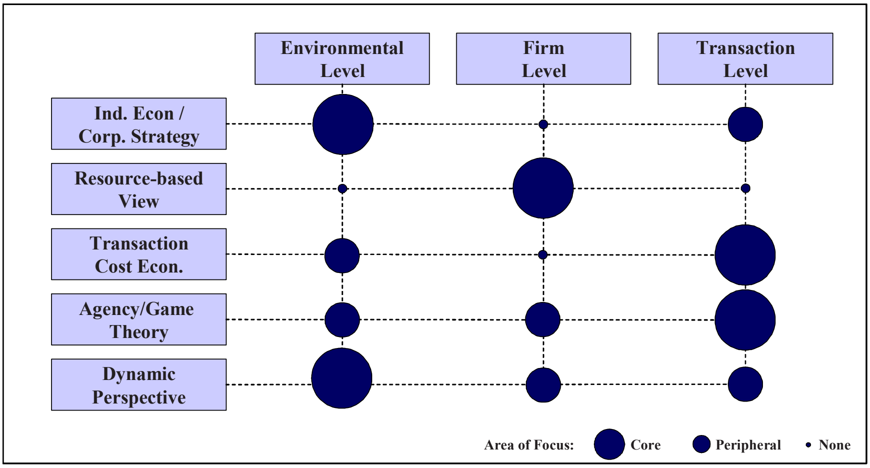
- Arguments based on agency and game theories (❹) extend the organizational design perspective to include specific information asymmetries, contractual provisions, and different sources of inter-partner trust. More specifically, information asymmetries between transaction partners as well as between managers and shareholders of collaborating firms reduce the net benefits of collaborative activity (similar to transaction costs). Conversely, alliances may also serve as signals of unobservable firm quality, which represents an additional source of collaborative value.
- The dynamic perspective (❺) explicitly considers evolutionary aspects, which moderate the value created by alliance activities. On the one hand, this relates to developments in the firm's environment and strategic needs, which may alter fundamental collaborative benefits. On the other hand, changing environments may also require the adaptation of alliances and networks. In this context, the flexibility associated with alliances may allow firms to reap greater value collaboratively (relative to other types of corporate combinations).

As its main deliverables, this chapter has presented a variety of theoretically founded and empirically validated propositions regarding the sources and limitations of collaborative benefits. These may serve as the founding stones for an assessment of specifically value-related evidence in the following chapter.

In addition to their distinct mechanisms of action, the approaches presented in this section also differ with regard to their levels of analysis. As illustrated in Figure 14, the five schools of thought refer to the firm's institutional or industry environments, its specific characteristics, and transaction characteristics.[203]

[203] This threefold structure builds on the distinction of competitive, partner-related, task-related, and institutional contexts of collaborative ventures proposed by (Merchant and Schendel 2000). It is also similar to the competitive, collaborative, organizational, and operational challenges to firms raised by (Bartlett and Ghoshal 1989). In contrast to both, it synthesizes all factors external to the collaborating firms (i.e., institutional and competitive in the (Merchant and Schendel 2000) framework).

Figure 14: Matrix linking Theoretical Foundations and Levels of Measurement



Source: Own Illustration

The differing focusses of the varied theoretical frameworks suggest that they complement each other in empirical research. At the same time, some drivers of collaborative value may not be free from overlap:

Strategic mechanisms focus on industry and firm-level sources of collaborative value.

- IO and market-based corporate strategy are founded on industry characteristics (such as concentration and competition), but also distinguish alliance functions, e.g., joint R&D activities.
- Resource-based considerations most closely focus on the individual firm. And while organizational learning essentially argues that firms may differently profit from individual transactions, indicators are generally measured on the firm level (e.g., alliance experience, absorptive capacity).

Organizational economics zoom in on transaction-level considerations:

- TCE primarily addresses the efficient choice of transaction governance. Yet, it also refers to environmental uncertainty as an institutional influence on governance choice, as well as to mimetic behavior at the industry level.
- Agency theories highlight the role of transaction-specific control structures. However, the information asymmetries underlying potential agency conflicts may be firm-specific or influenced institutional determinants (such as patent protection).

Finally, the dynamic perspective extends to all three levels of analysis, since dynamic influences may originate from environmental, firm, or transaction-inherent sources. While industry and firm-level dynamics primarily represent modifications to strategic alliance benefits (e.g., changing relevance of partner resources across firm-lifecycle stages), transaction-level dynamics present distinct sources of collaborative value (e.g., the creation and exercise of flexibilities in reaction to environmental uncertainty).

3 The Value Impact of Corporate Collaboration

"I can't change the fact that my paintings don't sell. But the time will come when people will recognize that they are worth more than the value of the paints used in the picture."

Vincent van Gogh

A significant body of research has addressed the effects of strategic alliances and joint ventures on firm value, although the breadth of prior event-study research is not as great as for M&A announcements.[204] This chapter provides an overview of existing evidence for the value firms create by corporate collaboration. This encompasses all value-related research (in particular, event studies) on alliance formation, termination, and other events relating to them.[205]

Rather than only reviewing value-related alliance research, however, this chapter appraises the value-related empirical support for the propositions derived in chapter 2. Such a comparison allows identifying achievements and limitations of existing event-study literature. On the one hand, factors found significant in prior event studies may be necessary controls for future research efforts. On the other hand, propositions not yet tested in a value-related context represent areas for future research. Consequently, this investigation is prerequisite for the subsequent empirical analysis.[206]

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[204] While the present work focuses on strategic alliances and JVs, M&A transactions may present interesting benchmarks for potential influences on collaborative value generation. Therefore, relevant and comparable evidence is summarized in the appendix and will be referred to where appropriate. For a more comprehensive review, see (Bruner 2002).

[205] This chapter focuses on the substantive contributions of the relevant studies. While these inquiries differed in their specific settings and methdological approaches, such differences should not induce systematic distortions. For an extensive discussion of methodological considerations, cf. subchapter 4.3.

[206] At the same time, it implies that the insights of this section are not inductive generalizations based on the limited number of existing event studies. They

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The present chapter proceeds as follows: Subchapter 3.1 reviews the overall impact of strategic alliances and joint venture formation as well as termination on shareholder value. Subchapter 3.2 addresses the drivers of cross-sectional variation in valuation effects. Finally, subchapter 3.3 discusses the achievements and shortcomings of prior value-related research vis-à-vis the broader spectrum of potential explanations raised in the preceding chapter. It culminates in deriving the hypotheses to be empirically tested.

3.1 Aggregate Effects on Firm Value

The impact of corporate collaboration on firm value has been extensively measured in the existing literature.[207] While some authors [e.g., (Koh and Venkatraman 1991), (Anand and Khanna 2000a)] consider both JVs and contractual alliances, others [e.g., focus on JVs, since they are more formally institutionalized. They may thus target longer-term joint activities and were extensively used as means for entering foreign markets (IJVs). The value impact of contractual alliances and JVs will therefore be assessed in sequence.

3.1.1 Strategic Alliances

Event studies on the stock returns to strategic alliances announcements make up the largest and most prominent share empirical work, including (Chan et al. 1997), (Das et al. 1998), (Anand and Khanna 2000a), (Kale et

rather mark empirical approximations of the theoretical concepts derived above.
As such measures may incorporate multiple theory-founded arguments, this chapter (and the subsequent novel empirical study) follows the empirical typology introduced in subchapter 2.5 (also see FN 203).

207 The approaches available in this context can be roughly classified into studies of short-term (or announcement) and long-term effects. In the domain of alliance-related research, the former approach has been prevalent. While long-run effects have been considered in M&A research, such an approach may not be feasible in a collaborative context due to (a) the greater number of similar transactions per firm and (b) the substantially smaller operational magnitude of these events. Complementarily, indirect value effects, i.e., interactions of collaborative portfolios with other events such as IPOs will be considered.

al. 2002), and (Park et al. 2004).[208] Similarly, (Das et al. 1998) and (Arend 2004) analyze the impact of collaboration announcements on stock volatility.[209] Two further approaches may also allow insights into the collaborative value generated by strategic alliances: First, (Allen and Phillips 2000) and (Janney and Folta 2003) study the value impact of collaborative arrangements bundled with block purchases and private equity placements, respectively. Second, (Stuart et al. 1999) and (Gulati and Higgins 2003) consider the influence of alliance portfolios on the returns entrepreneurial firms realize as part of an initial public offering (IPO). (Nicholson et al. 2002) and (Hand 2004) extend this analysis to venture-capital financing.

The overall value impact of entering into strategic alliances is clearly positive. All event studies observe significantly positive valuation effects upon the announcement of strategic alliances. Mean abnormal returns on the announcement day range from 0.5% [(Das et al. 1998)] to over 2.6% [(Park and Mezias 2005)] and are different from zero at standard significance levels. Similarly, (Allen and Phillips 2000) show that the positive abnormal returns to target firms in block purchases are significantly higher if the stock purchase is linked to an alliance agreement or joint venture. (Janney and Folta 2003) observe that the positive abnormal returns to private equity placements by publicly traded biotechnology firms are significantly higher if the transaction is bundled with a research alliance. These

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208 (Liu 2000) includes alliances as one of six types of news items, but does not further distinguish ARs. Consequently, this study rather falls into the general category of innovation-related event studies [see (Brockhoff 1999) for an overview]. Results will not be further discussed here.
Houston (2003) liberally interprets loan agreements as strategic alliances, but is include in this study. Bank loans have also been studied as signals of firm quality. The relevant literature, including (Mikkelson and Partch 1986), (James 1987), and (Lummer and McConnell 1989), among others, posits that banks may more capably evaluate borrowing firms and/or have preferred access to private information. Consequently, the documented announcement effects were significantly positive.

209 While (Arend 2004) observes some transaction characteristics to affect stock volatility, none of the three volatiliy measures used (two variants of volatility implied in stock options and the actual change in volatilatility before and after the announcement) indicates a general effect of collaborative ventures on company risk. (Das et al. 1998) also only observe a decline in the volatility of stock prices following certain types of alliance announcements (particularly R&D announcements). This suggests that collaboration does not per se reduce corporate investment risk and that the generally positive abnormal returns primarily result from increases in expected cash-flows and strategic flexibilities.

findings consistently indicate positive value creation for strategic alliance announcements.

Evidence outside the United States is less exclusive. (Brooke and Oliver 2004), (Karamanos 2002), and (Häussler 2006)[210] provide concurrent evidence positive announcement effects for Australia, the United Kingdom, and Germany, respectively. For Eastern Asia, (Chang and Kuo undated) and (Wang and Wu 2004)[211] also find positive abnormal returns. Conversely, (Bayona et al. 2002a), (Bayona et al. 2002b) and (García-Canal and Sánchez-Lorda Undated) do not observe significant abnormal returns to Spanish alliance announcements. This might raise doubt about the ability of some capital markets, even in established market economies, to efficiently incorporate this information. However, (Bayona et al. 2002b) observe abnormal return volatility and trading volumes around the announcement date, which suggests that the ARs may be insignificant on substantive grounds.[212]

Evidence on alliance portfolios is also largely supportive of collaborative value creation. (Stuart et al. 1999) and (Hand 2004) observe that the size of alliance networks (i.e., the number of strategic alliances) has a significantly positive effect on firm (pre-money) valuation in IPOs and VC

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210 (Häussler 2006) focuses on announcement-day abnormal return (3.8% significant at the 1% level), but does not report any cumulative abnormal returns. Additionally, she exhibits significantly positive abnormal returns for day t-2 and significantly negative returns for the days following the announcements (+1/+2). Consequently, the overall value impact may be less significant than reflected in the day 0 ARs. Note that (Häussler 2006) is referenced here for its greater international availability, whereas the same results were previously presented by (Socher 2004) and (Häussler 2005).

211 (Wang and Wu 2004) also do not report cumulative abnormal returns either. They exhibit significant ARs on the announcement day and the preceding day t-1 (both positive) as well as for day t+2 (negative), whereas all other days within an 11-day window (t-5 to t+5) are insignificant.

212 (Bayona et al. 2002a) offer two potential reasons for the abnormal announcement returns being insignificant. On the one hand, the benefits of strategic alliances may be too uncertain to induce substantial valuation effects upon announcement [in line with the ‘institutional investor hypothesis’, cf. (Woolridge and Snow 1990)] . On the other hand, the lack of a collaborative culture in Spain may render alliances less valuable. The latter is in line with higher returns documented by (Bayona et al. 2002a) for JVs (vs. contractual alliances), collaboration with public entities (vs. for-profit firms), as well as alliances with domestic partners targeting the domestic market (vs. international partners and markets).

financing rounds, respectively.[213] Similarly, (Nicholson et al. 2002) show that firms are valued more highly in VC financing and IPOs if they have entered into one or more alliances since the preceding financing round, even more so if it was their first such transaction. Surprisingly, (Gulati and Higgins 2003) do not find that the number of alliances with prominent partners has an effect on IPO success. This may, however, not be indicative of insignificant collaborative value overall, because they only account for alliances with the 30 largest pharmaceutical and healthcare organizations.[214] Furthermore, none of these studies consider the endogenous effect of alliances on variables of firm size, venture-capital financing, as well as venture capitalist and lead underwriter reputation used concurrently and found to be significant. The estimated value effects of alliance portfolios may thus be rather conservative.

Finally, some studies allow concluding that the immediate stock market reaction to the announcement of collaborative agreements is a suitable indicator for long-term value creation. Specifically, (Gleason et al. 2003) observe significantly positive long-run ARs for financial institutions engaging in collaborative ventures. On an operational level, (Allen and Phillips 2000) show that target firms in block purchases experience increased investment levels and improved operating cash flows if a collaboration is part of such transactions. Moreover, Kale/Dyer/Singh (2001, 2002) document a high level of correlation between event-study ARs and ex-post alliance success measured by managerial assessment years after the transaction.

Across the board, these findings point towards strategic alliances increasing firm value.

3.1.2 Joint Ventures

A variety of studies have singled out the value impact of joint ventures (i.e., excluding contractual forms of collaboration). In particular, one

[213] Additionally, (Stuart et al. 1999) discovered alliance portfolio size reducing the time to going public (see subsection 2.3.2.2). Conversely, (Hand 2004) does not confirm a similar effect on the value increases between venture-capital financing rounds or on excess returns to publicly traded stocks.

[214] This approach can be viewed as testing the hypothesis of the general alliance effect and a reputation effect associated with certain large partners to be jointly significant. Consequently, the failure to prove a significant influence cannot be attributed specifically to the alliance portfolio. For instance, alliances with other small high-growth firms or university-related research institutions may be equally valued by the IPO market.

stream of research [e.g., (McConnell and Nantell 1985), (Woolridge and Snow 1990), (Koh and Venkatraman 1991), and (Park and Kim 1997)] has generally addressed JVs. Another [e.g., (Chen et al. 2000), (Merchant and Schendel 2000), and (Hanvanich et al. 2003)] has explicitly focused on international JVs.[215]

General evidence on JVs is similar to that for strategic alliances. The overall value created by establishing JVs appears to be clearly positive, since all studies testing for ARs upon the announcement of JV formation find them to be positive and significantly different from zero.[216] Mirroring the evidence for strategic alliances, (Koh and Venkatraman 1991) also show that ARs are highly correlated with management assessment of JV success, which indicates that these announcement effects are linked to longer-term JV success.[217]

Findings regarding the value impact of IJVs are more diverse [see Merchant (2000) for a review of earlier studies]. Most recent [e.g., (Chen et al. 2000), (Merchant and Schendel 2000), (Reuer 2000), (Ueng et al. 2000), (Merchant 2002), and (Hanvanich et al. 2003)] and earlier studies [e.g., (Lummer and McConnell 1990), (Chen et al. 1991), (Crutchley et al. 1991), and (Gupta et al. 1991)] exhibit significantly positive abnormal returns. However, some studies detect a negative effect [e.g. (Lee and Wyatt

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[215] Note that general JV studies may include IJVs, since sample selection generally only refers to one parent. Similarly, contractual-alliance research entices both domestic and international collaboration.
While it was attempted to broadly cover published general work on strategic alliances and JVs, the existing literature on IJVs is too extensive to do so. Thus, only selected contributions can be presented here. Omitted studies of IJV impact were performed by (Lee and Wyatt 1990), (Lummer and McConnell 1989), (Chen et al. 1991), (Crutchley et al. 1991), (Gupta et al. 1991), (Chung et al. 1993), (Reuer and Miller 1997), and (Irwanto et al. 1999), among others.

[216] (Gulati and Wang 2001) do not provide such test results. In their sample, a roughly equal share of announcements yield positive and negative results. However, this does not necessarily reflect insignificant abnormal returns, since a zero-centered distribution of ARs (i.e., approx. zero median) may coincide with significantly positive mean ARs, if they are left-skewed (as they tend to be).

[217] Similarly, (Park and Kim 1997) show that JVs JVs still in existence at the end of the sample period had initially earned higher ARs than disbanded ones. This implies that annoncement AR at least partially incorporate the risk of failure.

1990) and (Chung et al. 1993)].[218] Moreover, (Irwanto et al. 1999) provide evidence that the value impact differs across sampling periods, being significantly positive for an early period (1972-1988) and insignificant later on (1989-1993).

While JVs thus generally increase firm value, this effect appears to be less pronounced for IJVs, which may be associated with insignificant wealth gains or even value destruction. This is consistent with the limited findings from JV parents from outside the U.S.. (Meschi 2004) and (Meschi et al. Undated) exhibit negative alliance announcement returns for Sino-French joint ventures. (Suresh et al. 2006) do not observe a significant value impact of JV announcements for Indian firms. In contrast, (Meschi and Cheng 2002) previously documented small but significantly positive abnormal returns for a pan-European sample.

3.1.3 Alliance/Joint Venture Termination

While the initiation of collaboration is value-creating, its discontinuation may reflect alliance failure, unless one of the collaborating firms chooses to internalize a successful venture (see subsection 2.4.2.3). In this context, several authors have considered the value impact of alliance or JV termination.

To the extent that collaborative failure induces alliance termination, it should have a negative value impact. Indeed, (Häussler 2006) shows significantly negative abnormal returns for German firms.[219] Conversely, (Reuer 2000) on average does not observe significant (positive or negative) abnormal returns for joint venture liquidation. This may reflect a difference in terminal value between alliances without proprietary resources and JVs, in which JV parents may profit by assimilating the JV's upon termination. Moreover, (Reuer 2000) finds the sale of JVs to external third parties associated with significant wealth gains. This suggests that selling off may be a viable strategy to realize residual JV value, provided that attractive exit channels (i.e., buyers) exist. In support, (Meschi 2005) shows that JV sell-offs pursuing debt reduction and strategic refocusing objectives

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[218] Some studies find no significant effects, such as (Reuer and Miller 1997), whose cumulative abnormal returns across a five-day event window is insignificantly different from zero. Similarly, (Gupta and Misra 2000) also fail to document significant value effects.

[219] Specifically, ARs to terminations are significantly negative for the announcement day and the day immediately preceding it. As indicated in FN 210, (Häussler 2006) does not provide cumulative ARs.

yield significant positive abnormal returns, whereas withdrawal from failing JVs incurs wealth losses.[220] Together, these findings indicate that the adverse effect of collaborative failure may be compensated by the value of JV resources or the external selling price for the JV entity.

As internalization (or JV buyouts) may represent the exercise of collaborative flexibilities, it should be value-enhancing. However, (Reuer and Miller 1997) find the ARs to joint-venture buyouts significantly negative and (Reuer 2000, 2001) observes no significant value effects. These findings indicate that other influences may offset the flexibility value JV internalization.[221] In particular, buyout returns may underlie similar agency effects as M&A transactions. For instance, (Reuer and Miller 1997) provide evidence of better JV buyouts value, if managerial ownership is high and available free-cash-flows are held in check by sufficiently high leverage. Similarly, (Reuer 2000) traces disadvantages to strategically not well substantiated internalization. He observes negative AR for the buyout of ex ante unattractive JVs outside the focal firm's main area of business.[222]

In brief, the termination of interorganizational collaboration may not only have negative valuation effects unless it merely reflects collaborative failure. In particular, JVs sell-offs or buyouts may create value, if they follow a strategic rationale.

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220 Quite interestingly, (Meschi 2005) primarily obtains significant abnormal returns for longer event windows (21 days), whereas short-term (3-, 5-day windows) are only significant for the "JV failure" subcase. A fourth reason, "involuntary" JV sell-offs due to anti-trust mandates or parters' exercise of buyout options, is not associated with significant abnormal returns. Finally, (Meschi 2005) also provides an overview of prior event-studies on asset sales in general.

221 Alternatively, announcement returns may become insignificant, if flexibility value already was correctly reflected in the stock price. In addition to market anticipation of the buyout, its likelihood may also have been considered at the time of alliance formation. Along those lines, (Park and Kim 1997) document that JVs later being dissolved initially earned significantly smaller ARs upon announcement than those eventually bought by one of the parent firms.

222 This argument is based on the assumption that ex ante attractiveness (proxied by the sign of ARs upon JV announcement) reflect the underlying value of a JV. Indeed, (Reuer 2000) shows that JVs which have been positively received by the market upon announcement also produce higher ARs when being internalized.

Moreover, (Reuer 2001) finds that R&D intensity (i.e., asset specifity) and low cultural distance increase buyout ARs, which may reflect the sensibility of internalizing specific operations under conditions of low perceived uncertainty (see subsection 2.3.1.2 for the corresponding TCE rationale).

Table 1 presents an overview of the evidence discussed in this section. Overall, findings clearly support the notion of collaborative value creation. Specifically, the formation of contractual alliances and joint ventures is associated with undisputedly positive valuation effects. Moreover, the sale or buyout of collaborative ventures may create firm value. Only the outright discontinuation of unsuccessful collaboration is consistently value-destroying.

Table 1: Summary of Evidence on Aggregate Value Impact

Type of Announcement	Effect	Significantly Positive AR	Significantly Negative AR	Insignificant AR / Inconclusive
Contractual Alliances	+	25	0	2
Joint Ventures				
-General/ Domestic	+	12	0	4
-International	(+)	7	3	7
Alliance/JV Termination				
- Dissolution	–	0	2	1
- Internalization	(+)	0	1	1
- Sell-Off	(+)	1	0	0

+/– unconditional positive/negative value impact
(+)/(–) potential positive/negative value impact

Source: Own Compilation

3.2 Drivers of Variation in Collaborative Value Creation

While the initiation of collaborative activities generally appears to be value-enhancing, its impact is subject to substantial heterogeneity. This subchapter further analyzes the factors having influenced the cross-sectional variation of announcement returns in prior event-study research. Based on the model employed to structure the theory-based arguments in chapter 2 (see subchapter 2.5), it distinguishes industry, firm, transaction, and institutional classes of influences.

3.2.1 Environmental Factors

The industry and broader institutional context of an alliance provides the background for collaborative value creation. The former comprise industry affiliation as well as the relatedness between collaborating parties. The latter alludes to the international dimension as well as general economic and capital-market conditions for a given transaction.

3.2.1.1 Industry Affiliation

The value-generation potential of corporate combinations may differ across industries. As illustrated by industrial economics and corporate strategy (section 2.2.1), the need for collaboration may depend on the level of competition (proposition 1.1), technological change (proposition 1.2), and the basis of competition (propositions 1.3-1.5) in a given industry. Furthermore, as transaction cost theory argues, the ability of collaboration to successfully serve its purpose varies with the levels of specific investments and environmental uncertainty (propositions 5.1a and 5.2 in subsection 2.3.1.2). Similarly, differences in patent protection affect the industry-specific level of information asymmetries (proposition 4.5 in 2.3.2.3).

Most alliance event studies do not distinguish industry affiliation or include only companies from a particular industry in order to avoid potential biases arising from pooling transactions from different industries.[223] Those studies controlling for industry affiliation (using a set dummy variables) provide no [e.g., (Mohanram and Nanda 1996)] or even contradictory evidence regarding its relevance. For instance, (Anand and Khanna 2000) show that alliances in computer and communication industries earn higher abnormal returns, whereas (Kale et al. 2002), using a similar approach and data set, observe that both insignificantly differ from other industries.

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223 Such examples include (Neill et al. 2001) and (Yao and Ge 2002), who analyze information systems and biotechnology companies, respectively. (Ravichandran and Sa-Aadu 1988) and (He et al. 1994) focus on joint ventures in the real-estate industry. (Gleason et al. 2003) and (Chiou and White 2005) observe significantly positive abnormal returns for financial services firms. However, (Chiou and White 2005), studying the Japanese financial services industry, observe a significant difference in the value of alliances in the investment banking or insurance and investment products businesses. Table 51 (Table 52) of the appendix provides an overview of the research settings in prior event studies (other value-related research) and their findings regarding the value impact of strategic alliances. Table 53 presents similar evidence for M&A studies.

While inter-industry variation in alliance AR does not appear to be fully systematic, some fundamental differences between industry settings may affect collaborative AR. Prior research has documented three such influences:[224]

First, the level of industry competition may increase the incentives for firms to collaboratively reduce competitive pressure (proposition 1.1 in subsection 2.2.1.2) or gain competitive advantage (proposition 1.5 in subsection 2.2.1.3). Along those lines, (Merchant and Schendel 2000) and (Merchant 2002) demonstrate that the intensity of industry competition positively affects collaborative ARs.[225] More specifically, (Chang et al. 2004) observe small but significantly negative wealth effects (-0.19%) of collaboration for non-participating industry rivals. These are inversely related to the abnormal gains for the collaborating firms, which indicates that the rivals loose competitive ground to the collaborators.[226] This contradicts the traditional market power view (proposition 1.1) in favor of competitive advantage arguments (propositions 1.5).

Second, industries may differ with regard to the knowledge spillovers (proposition 1.2 in subsection 2.2.1.2) and technological barriers to entry (proposition 1.3 in subsection 2.2.1.3). In particular, high-technology industries may present more attractive opportunities for technology-related collaboration. For the case of strategic alliances, (Chan et al. 1997) and (Häussler 2006) show significantly higher abnormal returns for high-technology firms.[227] Contrarily, (Brooke and Oliver 2004) find abnormal return differences insignificant and (Hanvanich et al. 2005) even observe an adverse effect of high-tech status for JVs. Collaborative value creation

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224 Table 54 of the appendix provides an overview of studies, variables used, and findings with regard to inter-industry differences in collaborative value creation.

225 While industrial economics generally argues based on structural alliance characteristics (in particular market concentration), (Merchant and Schendel 2000) and (Merchant 2002) more directly measure competitive rivalry using survey methods.

226 This effect is particularly strong for horizontal and equity-based alliances, which may reflect the long-term threat excerted by such collaboration. Finally, rival firm characteristics (size, growth opportunities) appear to moderate this effect, whereas industry characteristics (concentration, high-tech status) do not.

227 Similarly, (Kohers and Kohers 2000) find that corporate acquisitions in high-technology industries yield significantly positive abnormal returns on average in spite of higher takeover premia paid. This effect is even stronger in the cases of the bidder being a high-tech firm itself.

in high- and low-tech industries thus may differ substantially, although not systematically.

Third, different levels of information asymmetries between firms and capital-market participants may affect the signaling value of alliances (proposition 4.1 in subsection 2.3.2.2). In this context, (Madhavan and Prescott 1995) find the value impact of JVs to be significantly positive only for industries with relatively low and high information-processing loads (i.e., amounts of value-related information available for firms in a given industry).[228] This suggests that the signal associated with JV formation only is valuable when information is either scarce or too expansive to be considered in its entirety.

All of this evidence suggests that differences in value creation may exist across alternative market contexts. Different levels of intra-industry competition, knowledge spillovers or technological requirements, and information asymmetries may be specific explanations for such variation.

Control 1:	Abnormal returns to strategic alliance (or JV) announcements may differ systematically across different industries or market segments.

On a sub-industry level, several authors have addressed differences in the business models pursued by collaborating firms. For the IT sector, (Koh and Venkatraman 1991) distinguish between manufacturing and non-manufacturing firms, but find no substantial difference in ARs for JV formation. In e-commerce alliances, (Park et al. 2004) (Park and Mezias 2005) do not observe returns of firms following a business-to-business approach differing from those of internet portals or business-to-consumer firms. Similarly, the business model of the partnering firm (more specifically, whether it is a pure-play e-commerce firm or also has offline sales) does not have a significant impact on value creation. Thus, no evidence so far indicates differences in value creation across sub-groups of firms within a given industry.

[228] On the firm level, a similar argument also applies to the effect of firm size or age on announcement effects (see below), since larger firms are generally better covered by financial analysts. In fact, (Madhavan and Prescott 1995) use average firm size within a given industry as indicator of information processing load.

3.2.1.2 Business Relatedness

Relatedness may be the source of increased collaborative value creation.[229] From an industrial organization perspective, horizontal relatedness is prerequisite for market power (proposition 1.1 in subsection 2.2.1.2). Vertical relatedness may yield strategic advantages in market-entry alliances or collaborative product differentiation (propositions 1.3/1.5 in subsection 2.2.1.3). More generally, related knowledge bases facilitate interorganizational learning (proposition 2.5 in subsection 2.2.2.4).

Two types of relatedness may be relevant in this context: The relatedness between collaborating firms may differ from the relatedness of collaborative activities to focal firms' core businesses.

First, with regard to intra-industry alliances (i.e., between firms from the same industry), (Chan et al. 1997), (Bayona et al. 2002a), (Vidal Suarez and García-Canal 2003), and (Wang and Wu 2004) document a significantly higher value impact than for alliances formed across different industries. (Koh and Venkatraman 1991) and (Merchant 2002) come to concurrent conclusions for JVs. Conversely, some authors find that unrelated joint venturing [(Houston and Johnson 2000), (Reuer and Koza 2000a)] may be positively related to ARs.[230]

Second, evidence homogeneously points towards higher value for collaborative in related domains (see Table 55 of the appendix). (Bayona et al. 2002a) and Merchant/Schendel (2002) provide supportive evidence for contractual alliances and JVs, respectively. More particularly, (Koh and Venkatraman 1991) observe significant ARs only for joint ventures targeting an existing customer base (i.e., identical or complementary product offerings). (Ravichandran and Sa-Aadu 1988) find that geographical proximity and technological expertise in the area of joint venturing increase abnormal returns in real estate JVs. Similarly, (Gulati and Wang 2001) and

229 The most common approach, relying on Standard Industry Classifications (SIC codes), indicates purely horizontal alliances, given that a fine-grained (4-digit) level is used. If a cruder approximation (e.g., 2-digit SIC codes) is applied, the notion of relatedness becomes less well defined. It is noteworthy that even 4-digit SIC codes do not account for heterogeneous competition within a given industry. Following the general idea of strategic groups [cf. (Porter 1979)], a more refined distinction of strategic relatedness would be required. Hand-coded data (i.e., case-by-case assessments) such as used by (Houston and Johnson 2000) and (Merchant and Schendel 2000) may be steps into this direction.

230 Moreover, various authors do do not find relatedness significantly related to JV [(Merchant and Schendel 2000), (Gulati and Wang 2001)] and strategic alliance [(Karamanos 2002), (Häussler 2006)] announcement returns.

(Schut and Van Fredrikslust 2002) show JVs unrelated to parent firms (different 2-digit SIC code and normalized difference between parent and JV, respectively) are associated with negative announcement returns.

These contradictory findings may reflect that while relatedness provides strategic benefits, it also incurs the risk of intra-alliance rivalry and limits learning opportunities, if collaborating firms are close competitors. In particular, (Mohanram and Nanda 1996) and (Park and Kim 1997) observe significantly positive abnormal returns for joint ventures related to focal firms' primary areas of business, but lower ARs if partner firms are direct competitors (i.e., same 4-digit SIC code).[231]

The adverse effect of close relatedness on collaborative AR suggests that collusive objectives may be less important than synergetic ones. Furthermore, the type of partner relatedness does not support market-power considerations either.[232] In particular, (Chan et al. 1997) show higher ARs for within-industry technology alliances as well as across-industry non-technology (e.g., marketing) alliances. Similarly, (Gleason et al. 2003) observe that domestic diversifying alliances as well as international scale (i.e., horizontal) and scope (i.e., diversifying) alliances yield significantly positive abnormal returns, whereas domestic horizontal alliances do not.

Overall, relatedness to alliance partners and to the domain of collaborative activity appears to have a positive effect. In particular, related collaboration may allow developing new product offerings (propositions 1.3/1.5) and facilitating collaborative learning (proposition 2.5). Contrary to the market power argument (proposition 1.1), however, the benefits of collaboration decline for direct competitors and horizontal relatedness appears to be primarily linked to technological considerations.

231 Complementarily, (Balakrishnan and Koza 1993) observe positive effects of business dissimilarity (normalized difference in 3-digit SIC codes) and both partners being in the same industry (3-digit SIC code). They suggest that learning opportunities due to diversity and market-power effects arising from relatedness may be complementary sources of collaborative wealth gains.

232 While (Houston and Johnson 2000) document higher overall returns for horizontal and downstream (supplier) rather than upstream (buyer) vertical joint ventures, most studies do not observe significantly different ARs for alternative types of relatedness [e.g., (Häussler 2006), (García-Canal and Sánchez-Lorda Undated)]. Conversely, evidence on M&A indicates that horizontal transactions yield significantly higher ARs, which nay suggest that M&A is better suited to pursue market power advantages and economies of scale.

Table 56 of the appendix provides a summary of relavant M&A event studies.

Control 2:	The extent and type of relatedness between collaborating firms (and to the area of collaboration) may affect collaborative value creation.

3.2.1.3 International and Intercultural Aspects

While few studies have exclusively focused on domestic alliances [e.g., (Johnson and Houston 2000)], their value impact may differ substantially from international collaboration. Market access may be a particularly important motive internationally (proposition 1.3 in subsection 2.2.1.3). At the same time, collaborating in an international context may be associated with greater uncertainty and coordination costs (propositions 3.2/3.4 in subsection 2.2.1.2).

Empirical evidence on the value created by domestic and international collaboration, however, is highly ambivalent.[233] On one hand, (Kim and Park 2002) find higher abnormal returns for international as opposed to domestic alliances. (García-Canal and Sánchez-Lorda Undated) also observe greater value creation for multi-country or even global alliances. On the other hand, (Hanvanich et al. 2005) and (Wang and Wu 2004) observe that JVs (and alliances) with domestic partners are perceived more favorably. Similarly, (Hanvanich et al. 2003) show that JVs established in the focal firm's home country are associated with higher announcement ARs.[234] Such inconclusive findings may be due to variation in the value created by alliances (a) with partner firms from different backgrounds, (b) targeting different markets, and (c) subjecting firms to more of less culturally different circumstances.

First, the specific origin of cooperation partners and acquisition targets has a significant impact on value-creation. Early studies such as those by (Lee and Wyatt 1990) and (Irwanto et al. 1999) found that JVs with partners from developing (rather than industrialized) countries are linked to higher ARs. This presumably reflects the benefits derived from entering these markets or gaining access to low-cost production capacity. More recently, (Hanvanich et al. 2003) and (Sleuwaegen et al. 2003) provide evidence to the contrary for JVs and alliances, respectively.[235] In many alli-

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233 See Table 57 and Table 58 in the appendix, as well as Table 59 for evidence in M&A research.

234 Finally, (He et al. 1994) and (Park and Kim 1997) do not provide evidence of significantly different value creation for domestic and international JVs.

235 In particular, (Sleuwaegen et al. 2003) show that partners from within the EU offer greater returns than other partners. Not only do (Hanvanich et al. 2003) exihibit higher returns for JVs in the focal firms' home countries (see above),

ance contexts, however, evidence has not furthered any significant AR differences across different partner origins [e.g., (Vidal Suarez and García-Canal 2003), (Chiou and White 2005), (Häussler 2006)].

Second, collaborative value may vary across different host countries. (Ueng et al. 2000) show that JVs in developed countries yield higher abnormal returns than those established in developing nations. Similarly, (Jones and Danbolt 2004) observe higher (lower) AR for JVs in European (Asian-Pacific) markets vis-à-vis domestic alliances within the UK. While this evidence points towards collaboration in more established target markets being more valuable, (Merchant and Schendel 2000), (Merchant 2002), and (García-Canal and Sánchez-Lorda Undated) fail to link collaborative value creation to political risks and constraints faced in a given host country.

Third, the level of cultural relatedness between collaborators and to the host country may drive the observed differences in value creation. Some evidence points towards cultural similarity allowing for higher value creation in alliances [(Kim and Park 2002)] and joint ventures [(Hanvanich et al. 2003)]. Other authors [cf. (Merchant and Schendel 2000), (Merchant 2002), and (Vidal Suarez and García-Canal 2003)] find its influence insignificant. (Schut and Van Fredrikslust 2002) even find that cultural distances increases collaborative value creation.

Overall, there thus is some evidence that collaborative internationalization may be value-enhancing. The generally findings, however, show little coherence. International and intercultural differences thus may be of limited importance relative to other industry, firm, and transaction characteristics.[236]

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but traditional host country JVs (i.e., with an international firm in its home country) perform substantially worse than international JVs involving two domestic (cross-national) or an international partner outside of its home market (tri-national). This evidence may reflect that foreign partner firms may use their superior information to derive private benefits, when collaborating on their home turf.

236 In addition, the value of international collaboration may be affected by a focal firms' prior level of internationalization. (Meschi et al. Undated) and (Meschi 2004) find that prior international business experience is positively related to the collaborative ARs. Conversely, (Hu et al. 1992) find firms with lower prior international exposure to profit more from entering into international joint ventures. The advantages of prior market knowledge thus may be negatively related to the substantive advantages of internationalization. Along those lines, (Meschi 2004) observes that prior presence in Asia does not provide additional benefits. Yet, firms highly focused on the European market are in a worse position to benefit from JVs in China [(Meschi et al. Undated)].

Control 3:	International and domestic collaboration may differently affect firm value and partner origin may have a similarly discriminating effect.

3.2.1.4 General Economic Conditions

The general economic conditions under which an alliance is consummated may affect the strategic benefits of collaboration. In particular, environmental challenges increase and alternative growth opportunities diminish the potential for collaborative value creation (proposition 5.1a in subsection 2.4.2.1).

First, capital-market conditions reflect general economic circumstances and more particularly the availability of outside financing, which may reduce the relative benefits of collaboratively accessing resources.[237] Along those lines, (Park and Mezias 2005) observe substantially higher ARs during periods of low environmental munificence (i.e., low stock valuation and difficulties in gaining additional financing following the e-Commerce stock-market crash).[238] Similarly, (Schut and Van Fredrikslust 2002) find that (risk-free) interest rates have a significantly negative relation to the value of JV formation. Eras of economic growth thus are consistently related to depleted collaborative value (in line with proposition 5.1a).

Second, existing growth opportunities may be similarly related to the benefits of collaboration. In contrast, (Chen et al. 2000) and Suarez/Garcia-Canal (2003) present significant positive effects of Tobin's q on focal firms' ARs to JV formation. For contractual alliances, however, (Brooke and Oliver 2004) show that firms without significant growth opportunities

[237] The effect of capital-market conditions is more obvious for M&A transactions involving publicly traded target firms. In fact, recent research has outlined that capital-market conditions are of great importance in explaining management decisions, e.g., those on M&A [cf. Auster/Sirower (2002), Bouwman/Fuller/Nain (2003), and Dong et al. (2003)].

[238] More specifically, (Park and Mezias 2005) document that transactions generating revenue (i.e., marketing alliances) and reputation (i.e., with brick-and-mortar partners) are more valuable under adverse capital-market conditions. This reinforces the substitutive nature of alliance-based and other external resource access. (Park and Mezias 2005) operationalize environmental munificence as a dummy variable (before/after March 2000). A concurrently used stock-return measure comes out insignificant, suggesting that smaller differences in stock returns (i.e., within each time-period) do not make a substantial difference.

(lowest 10% q segment) experience higher ARs.[239] While JVs thus may be primarily used to leverage existing growth options, contractual alliances may allow firms to overcome the barriers to development arising from unfavorable environmental conditions.

In all, environmental circumstances provide the backdrop for collaborative value creation. In particular, favorable capital-market conditions may render collaboration less valuable, as alternative sources of capital and growth options accrue. Contractual alliances may be particularly suitable to realize these benefits, whereas JVs may build on existing internal growth opportunities.

Control 4:	Favorable environmental situations, in particular capital-market conditions, may be associated with reduced collaborative value creation.

3.2.2 Firm-Level Factors

Explanatory factors at the firm level may relate to both the focal firm and its partner(s). Specifically, these include firm size, resource endowments, transaction experience, financial performance, and corporate governance.

3.2.2.1 Focal Firm Size

With regard to collaborative activity and benefits, focal firm size may reflect market power (proposition 1.1 in 2.2.1.1), commercial resources (proposition 2.2 in 2.2.2.2), information asymmetries (proposition 4.1 in 2.3.2.2) or more generally company development (proposition 5.3 in 2.4.2.1). In event-study research, focal firm size has been considered both in absolute terms and relative to the size of the partnering firm.

A focal firm's absolute size may to some extent reflect its internal resource base and thus the importance of accessing other firms' resources through corporate combinations. Many studies of wealth creation through strategic alliances [cf. (Anand and Khanna 2000), (Kale et al. 2002), (Kim and Park 2002), and (Park et al. 2004)] address such size effects, but fail to

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239 As all these studies encompass a variety of industries, the different effects of q may also reflect variation in sample composition. In support, (Schut and Van Fredrikslust 2002) find that the deviation of q at the time of the transaction from an historic benchmark has no significant valuation effect. That is, the influence of time-varying environmental conditions (i.e., change in the market-value component in q) may be less important than time-invariant differences in q across different industry settings.

find them significant (using various measures of firm size, including total assets, sales, and market capitalization). Some studies on joint ventures controlling for firm size [e.g., (Gulati and Wang 2001)] equally show no significant effect or even a positive association with ARs [(Merchant and Schendel 2000)]. Contrarily, (Campart and Pfister 2003), (Park and Mezias 2005), and (Häussler 2005) as well as (Mohanram and Nanda 1996) document a significantly negative effect of firm size on ARs to alliance and JV announcements, respectively. In this context, discounted event effects for larger firms may be attributed to measurement uncertainty (attenuation bias) regarding a large, multi-business firm. Similarly, it may reflect the smaller relative value impact for a larger entity (relative size hypothesis).[240] While larger firms experience substantially negative ARs in M&A event studies [e.g., Asquith/Bruner/Mullins (1983)], however, larger companies are not equally discounted when entering into alliances or joint ventures.[241]

While the adverse effect of focal firm size on ARs may indicate a reduce relevance of external resource access (proposition 5.3) or lower information asymmetries vis-à-vis the capital market (proposition 4.1), the relative size of partner firms reflects their potential contributions in terms of commercial capital (proposition 2.2) or signaling effects. Along those lines, (Chan et al. 1997) and Das/Sen/Senupta (1998) show that the smaller alliance partner on average realizes larger ARs than the larger one. (Koh and Venkatraman 1991), (Gulati and Wang 2001), and (Schut and Van Fredrikslust 2002) demonstrate a similar (negative) relative size effect for JVs.[242] Moreover, (Gulati and Wang 2001) exhibit similarly large firms realizing rather homogeneous returns. Ceteris paribus, larger partners thus

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240 Alternatively, such differences may be due to scaling issues. For instance, (McConnell and Nantell 1985) and (Chan et al. 1997), both of whom show a significant value increase for all partners, differentiate between percentage and absolute dollar returns. While the abnormal percentage returns are significantly higher for the smaller parent, its absolute wealth gains (in $) are smaller than or equal to those of the larger partner. This is also supported by (Mohanram and Nanda 1996), who show value-weighted abnormal returns to be insignificant as opposed to significant returns to the respectively smaller parent company.

241 See Table 60 and Table 61 of the appendix for an overview of the evidence regarding size effects in alliance, JV, and M&A event studies, respectively.

242 (Merchant and Schendel 2000) and (Kim and Park 2002) observe relative size to be insignificant in international joint ventures and alliances, respectively. (Crutchley et al. 1991) even find relatively larger Japanese firms experiencing higher abnormal retuns, whereas the effect remains insignificant for U.S. firms.

may provide greater benefits in collaborative ventures. However, (Neill et al. 2001) find no effect of relative size in high-technology alliances after having corrected for absolute firm size as part of their event study methodology (also see subsection 4.3.1.1). It thus appears difficult to discern the relative from the absolute size-effect.

Overall, the evidence on absolute and relative firm size effects indicates that smaller firms tend to more strongly benefit from collaboration announcements. While this may reflect the greater value of commercial resources and reputation effects[243] provided by (larger) partners, it may also be an artifact of lower market capitalization, i.e., similar absolute wealth gains being relatively more important.

Control 5:	The ARs to alliances and JV announcements may decrease with (absolute and/or relative) firm size.

3.2.2.2 Firm Resources

Firm-level analysis may extend to explicitly considering resource transfers. According to the RBV (section 2.2.1.3), the access to a partner firm's resource base may value-enhancing. In particular, such strategic benefits may arise from three types of partner resources: Technological, commercial and social capital (see Table 62 of the appendix).

First, technological partner resources may be the source of collaborative value creation (proposition 2.1). Specifically, (Yao and Ge 2002) distinguish between the quantitative and qualitative dimensions of cooperation partners' patent bases. They observe a positive effect of quality-adjusted technological capital (measured by the number of patent citations) on collaborative value creation, whereas the mere number of patents does not have such an effect. Given the clarity of these findings, it is surprising that no other study has explicitly considered partner firms' technological endowments.

Second, commercial partner capital may hold a similar value potential (proposition 2.2). In the context of the global airline industry, (Park and Martin 2001) observe partner-firm commercial resources increasing collaborative value creation provided that they are commercially valuable, rare, and inimitable. In particular, partner firm air traffic volume may allow valuable cost and spillover synergies (value), which are sustainable if

[243] However, (Park et al. 2004), (Park and Mezias 2005), and (Häussler 2006) document that ARs are significantly positively related to firm age (i.e., time since the company's IPO). As information asymmetries should be smaller for established firms, this contradicts the agency-based rationale (proposition 4.1).

the partner holds strong positions at important hubs (rareness) and few other carriers from offer service from these hubs or sufficiently close locations (inimitability). Studying loan announcements as a form of alliance, Houston (2003) shows that the loaning institution's ability selecting only bona fide debtors, e.g., proxied by the expected rate of loan losses (relative to total loans), has a significantly positive impact on the announcement effect. While both studies lend support to the proposed effect of commercial capital, they may be limited due to their very specific industry settings.[244]

Third, (Stuart et al. 1999) document a positive effect of partner firms' entrenchment in commercial networks on IPO valuations.[245] (Yao and Ge 2002) distinguish the mere size of partner firms' social network (i.e., number of ties) from its efficiency (i.e., non-redundancy) and only find the latter value enhancing. More unique social capital thus holds greater value. In addition, (Karamanos 2002) observes a positive value impact of partner network centrality as opposed to a negative effect of focal-firm network centrality on alliance-formation ARs.[246] Consequently, partner firms' social capital may substitute for proprietary one and provide similar benefits (proposition 1.3 in 2.2.2.3).

In line with the RBV, all three types of partner resources may be sources of collaborative value creation. The extent thereof, however, may vary with the quality of resources, the sustainability of their benefits, and their internal availability.

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244 Capron/Pistre (2002) further extend such resource considerations to post-acquisition settins. While the transfer of technological and managerial resources from the acquirer to the target is associated with higher abnormal returns, a similar transfer of marketing know-how has a detrimental effect. While technological and managerial resources may be easily transferred or "expatriated" into the acquired firm, market-specific knowledge may be less codifiable (i.e., tacid) and thus more difficult to transfer effectively. Conversely, transferring marketing resources from the target into the acquiring firm leads to significantly higher abnormal returns.

245 Conversely, (Stuart et al. 1999) do not observe a significant effect of the cumulative financing volume contributed by alliance partners. Consequently, the value derived from social capital (i.e., network positioning) may be more important for the development of these firms than the direct economic benefits of collaboration.

246 Similarly, (Stuart et al. 1999) highlight the negative interaction effect between partners' reputation and financial contributions and the focal firm position in the respective area. This suggests that firm already possessing certain resources do not gain from cooperating with similarly endowed firms.

Control 6:	Partner firms' technological, commercial, and social resources may positively affect the value created by collaborative agreements.

3.2.2.3 Alliance Experience

Alliance experience may allow firms to develop collaborative competence, i.e., to better identify suitable alliance partners, devise alliance contracts, and manage collaborations (proposition 2.4 in subsection 2.2.2.4).

Value-related evidence, however, is controversial (see Table 63 of the appendix for an overview): (Anand and Khanna 2000) first explicitly considered the influence of collaborative experience on abnormal returns and show it to be significant for JVs, but not for contractual alliances. Since then, (Gupta and Misra 2000), (Merchant 2003), and (Meschi 2004) provide support for experience effects in JVs. Contrarily, other studies fail to show a significantly positive relationship between the number of prior transactions and value creation, in particular contractual alliances [(Park and Martin 2001), (Karamanos 2002), (Kim and Park 2002), (García-Canal and Sánchez-Lorda Undated) and (Park et al. 2004)], but also for JVs [(Merchant and Schendel 2000)]. Overall, experience thus may be value, when initial collaborative structures are implemented for the long run and financial commitments may be substantial.

Moreover, the potential benefits of alliance experience may need to be realized and may not apply to all contexts:

First, the development of collaborative competence requires learning from alliance experience, e.g., through the establishment of a dedicated structures [cf. (Kale et al. 2001)]. Along those lines, (Kale et al. 2002) observe that the existence of an alliance management function increases the ARs to alliance formation, even controlling for endogenous effect of alliance experience on the set-up of such an office. A dedicated alliance management function may directly reflect learning from prior experience and thus serve as a mediator for the value of alliance experience.[247]

Second, the specific characteristics of prior transactions may determine organizational learning and thus moderate experience effects for later transactions. On one hand, (Anand and Khanna 2000) demonstrate positive

[247] The value impact of alliance experience may be indirect, since it significantly increases the likelihood of forming an alliance management function. While alliance experience has a positive impact of collaborative value without accounting for this interdependence, (Kale et al. 2001, 2002) show that it is insignificant in explaining collaborative ARs, when concurrently considering the likelihood of an alliance management office having been implemented.

experience effects only for research and production joint ventures as opposed to marketing joint ventures and licensing agreements. Learning 'how to collaborate' thus may only be relevant for certain functional areas. On the other hand, (Gupta and Misra 2000) and (Meschi 2004) only refer to JV experience in the respective target country. Consequently, collaborative settings may have to be sufficiently similar for prior alliance experience to have the desired effects.[248]

Third, collaborative activity may mitigate extra-alliance information asymmetries (proposition 4.1), which in return would reduce the value an individual alliance holds as a signal of firm quality. For instance, (Nicholson et al. 2002) show that entrepreneurial firms receive a significant valuation boost in the VC financing round (or IPO) succeeding the announcement of their first collaborative agreement. Similarly, (Janney and Folta 2003) document a significantly positive relation between the time passed since the last prior research alliance and the abnormal returns earned in private-equity placements.[249] This evidence suggests that the learning effects of prior alliances may be equalized by the reduction in signaling effects associated with frequent transactions.

In total, alliance experience may have a positive impact on value creation. However, the collaborative competence may require the development of appropriate internal structures and may be limited to specific collaborative functions (e.g., manufacturing) and governance modes (in particular, JVs). Mistiming (i.e., too frequent collaboration) may offset the value impact of alliance experience.

Control 7:	Focal firms' prior transaction experience may have a significantly positive value impact to new alliance formation announcements.

While the evidence alliance experience refers only to the individual firm, repeated collaboration may allow collaborative routines to develop across organizational boundaries. Equally important, trust may evolve over the duration of a relationship (proposition 4.3 in subsection 2.3.2.3). Both in-

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248 For M&A, (Hayward 2002), while showing a negative net coefficient for the number of prior acquisitions, finds that earlier transactions targeting the same industry and incurring small wealth losses lead to significantly higher ARs in subsequent acquisitions. Similarly, he documents a significantly positive (but marginally decreasing) relationship between the time passed between prior acquisitions and wealth effect.

249 (Chaney et al. 1991) observe a similar low-frequency effect for the case of new product announcements.

terorganizational routines and trust may facilitate value creation for collaborating parties already maintain prior relations.[250]

The empirical evidence on this issue, however, is mixed. (Bayona et al. 2002a) document larger ARs for repeated collaboration, which they attribute to the high premium for risk reduction in the Spanish stock market. (Gulati and Wang 2001) extend this train of thought to include common relations with other organizations. They show that tie embeddedness (i.e., the number of prior JVs between JV parents and with common partners) increases overall value creation (i.e., accruing to both partners).[251] Conversely, (Vidal Suarez and García-Canal 2003) do not find prior ties to an alliance partner a significant explanatory parameter for value creation. (Park and Kim 1997) even observe that firms having previous relations with a JV partner experience lower abnormal returns.

This may reflect a tradeoff between the trust and learning routines established in repeated partnering and the potentially greater benefits of collaborating with new partners. In support, (Gulati and Wang 2001) show that the effect of embeddedness declines at the margin, indicating limited value added by large numbers of redundant ties. Similarly, (Park and Kim 1997) find that only larger firms experience the negative effect of prior relations on ARs.

Overall, prior partner ties may facilitate collaborative value creation. While deepening partner relations thus may be beneficial, broadening the spectrum of collaborating firms remains equally important.

Control 8:	Prior relations between collaborating parties may increase collaborative value creation, unless they are overused.

3.2.2.4 Firm Performance and Governance

Satisfactory firm performance may provide the basis for managerial discretion, i.e., collaboration in pursuit of private benefits (proposition 4.1a in subsection 2.3.2.2). Profits and particularly free cash flows (FCFs) may be mishandled, unless management is restrained by appropriate incentive and

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[250] Note that premia for repeated interactions not only may reflect reduced ex post opportunism, but also higher ex ante knowledge (i.e., lower information asymmetry) regarding partner quality. Along those lines, (Cordeiro 1993) found the number of board interlocks increasing the valuation effects of JV formation, possibly due to better information on potential collaboration partners.

[251] Additionally, tie embeddedness also increases differences in value appropriation, which may reflect that asymmetric transaction structures are more feasible for partners who interact repeatedly.

governance mechanisms. Alternatively, profitable firms may stand to gain less from collaboration due to limited external pressure (proposition 5.1 in subsection 2.4.2.1) and sufficient internal commercial capital (proposition 5.3 in subsection 2.4.2.2). In any case, firm performance is expected to reduce the value of collaboration. The agency-based argumentation also implies that leverage and incentivizing ownership structures may mitigate the agency costs of FCF [cf. (Jensen 1986)].

First, with regard to firm profitability, (Das et al. 1998), (Kim and Park 2002), and (Chang and Kuo undated) exhibit a significantly negative relationship to the value of contractual alliances. Conversely, (Campart and Pfister 2003) observes a positive impact of profitability in pharmaceutical alliances, which may reflect that pharma firms use their profits to collaboratively broaden their product pipeline. While profitability overall appears to reduce the value of contractual collaboration, evidence for JVs is mostly insignificant [e.g., (Chen et al. 2000), (Gupta and Misra 2000), (Ueng et al. 2000), (Gulati and Wang 2001)].[252] Only (Mohanram and Nanda 1996) show that the level of FCFs earned by joint venturing firms as well as their sales growth have a negative effect on abnormal announcement returns. Overall, profitability thus may have a generally negative value impact, which may be offset by concurrent benefits in JVs (e.g., market power in highly concentrated and profitable settings).

Second, financially constrained firms should be expected to only enter into value-creating collaborative ventures. However, the majority of studies does not observe significant effects of leverage-related variables on ARs to JV parents [(Chen et al. 2000), (Gulati and Wang 2001)] and firms entering contractual alliances [(Chang and Kuo undated)]. (Mohanram and Nanda 1996) even suggest that JV wealth gains are negatively associated with the degree of leverage. While the evidence on leverage is clearly supportive of the agency view for M&A,[253] it thus contradicts the agency-based rationale for alliances and JVs.

Third, firm ownership structures may reduce the risk arising from managerial discretion. The only study considering such issues with regard to contractual alliances, (Chang and Kuo undated), does not find a significant effect of managerial ownership on value creation. In contrast, (Park and Kim 1997) document a positive effect of both institutional and insider ownership in JV parent firms and announcement ARs. (Cordeiro 1993) supports this evidence for insider ownership, but not for institutional own-

[252] More specifically, (Gulati and Wang 2001) show that firms similar in profits also earn similar ARs upon announcing JVs.

[253] See Table 65 of the appendix for related M&A findings, as opposed to the rather unspportive evidence for alliances in Table 64 of the appendix.

ership or outside director supervision. This suggests that incentive alignment may serve to ensure value-creating decision making in JV formation.

The presented findings on firm performance indicate that it has the anticipated negative value impact, particularly for contractual alliances. As neither leverage nor ownership structure affected value creation in non-equity collaboration, this may be primarily due to the reduced benefits for high-performing firms (propositions 5.1/5.3) rather than agency problems (proposition 4.1). For JVs, managerial ownership increases collaborative ARs and may be the reason for profitability not necessarily reducing collaborative wealth gains (supporting proposition 4.1).[254]

Control 9:	Focal firm performance (in particular profitability) may reduce collaborative value.

3.2.3 Transaction-Specific Factors

Relevant transaction parameters include the alliance function, as well as the alliance's structural and financial set-up.

3.2.3.1 Strategic Transaction Characteristics

The alliance function (i.e., the functional focus of a given collaboration) is the primary dimension of a collaboration's strategic context (also see Table 66 of the appendix).[255] In particular, the alliances may address technology, marketing or manufacturing-related objectives. While technology-related collaboration may most prominently help rectify R&D incentives (proposition 1.2) or gain access to new markets (proposition 1.3), marketing and

[254] As JVs do not play a prominent role in the empirical sample (see subsection 4.2.1.3), the present study refrains from controlling for managerial ownership. Furthermore, given its developing state and the large share of recent IPOs (see subsection 1.3.2.2), high managerial ownership and limited resource endowments should render agency problems neglible in European biotechnology industry.

[255] (Schut and Van Fredrikslust 2002) consider the 'strategy content' as constituted by the 'underlying motive' for collaboration and the 'degree of diversification' (or relatedness, see subsection 3.2.1.2). Nomenclature regarding the former aspect is quite diverse: For instance, (Merchant 2002) refers to a JV's 'functional role'. In the present work, alliance function, functional area, and functional objective are used synonymously. Table 66 (Table 68) of the appendix provides an overview of evidence on different strategic aspects of alliances (M&A transactions).

manufacturing alliances may primarily serve to gain comparative cost or differentiation advantages (proposition 1.5).

On a general level, most studies observe that technology-related alliances are associated with greater value creation than other functional focuses [e.g., (Das/Sen/Sengupta 1998)[256], (Karamanos 2002) and (Campart and Pfister 2003)]. (Koh and Venkatraman 1991), (Merchant/Schendel 2000) , and (Merchant 2002) support this view for JVs. While those studies generally focused on the U.S., recent studies have failed to demonstrate significant differences in AR across functional areas of collaboration in Australia [(Brooke and Oliver 2004)], Germany [(Häussler 2006)], and Spain [(García-Canal and Sánchez-Lorda Undated)].[257] Moreover, (Park et al. 2004) show marketing alliances as more value-increasing than technology-related ones for e-commerce firms. The specific valuation impact may thus be industry- and/or country-specific. In particular, the most valuable alliance objectives may depend on the most pressing needs of firms in a given context.

In most settings, technology-motivated alliances and JVs appear to yield superior announcement gains. Firms may benefit from internalizing knowledge spillovers (proposition 1.2) or jointly developing new product offerings (propositions 1.3/1.5).

Control 10:	Collaborative value creation may differ across functional alliance focuses, depending on the given alliance context.

Moreover, the value associated with the main alliance function, in particular technology-related objectives, may be moderated by further transaction characteristics.[258] In particular, the distinction of resource generation and

256 (Das/Sen/Sengupta 1998) also observe a significant decline in stock price volatility (i.e., risk) following technology alliances, as opposed to an increase in volatility associated with marketing alliances.

257 For the Netherlands, (Sleuwaegen et al. 2003) and (Schut and Van Fredrikslust 2002) provide conflicting findings. While the former exhibit positive AR only for production and marketing, but not technology-related alliances, the latter find that technology- and efficiency-motivated JVs outperform marketing JVs.

258 Additionally, firm characteristics, such as size, may affect the value of specific transaction functions. For instance, (Das/Sen/Sengupta 1998) find that the above relative size effect is significant mostly for technology alliances. This suggests that smaller firms may profit from using alliances to gain access to technological resources or to leverage its existing technology base. Conversely, (Neill et al. 2001) observe no such difference in their sample of high-technology R&D alliances, which may be due to smaller size-differences among this group of firms.

transfers, the direction of resource transfers, and the scope of collaborative activities may detail the strategic context of an alliance.

First, exploiting existing technological resources may yield greater (or more immediate) returns than the generation of new resources. For instance, (Woolridge and Snow 1990) show that JVs based on asset sharing (i.e., licensing) are sources of larger wealth gains than those leading to asset construction (i.e., joint R&D). Similarly, (Chan et al. 1997) observe significantly positive value effects only for transactions enabling the transfer or pooling of technological knowledge, whereas R&D collaboration does not yield additional ARs. Similarly, (Karamanos 2002) observes (technology) commercialization outperforming R&D alliances. However, (Neill et al. 2001) find significantly positive abnormal returns in R&D agreements between information technology companies. While, technology licensing and transfer agreements may allow greater ARs than technology development, the relationship may thus be context-dependent.

Second, the value impact on buyers and suppliers in vertical (e.g., technology exchange) agreements may differ. On one hand, (Campart and Pfister 2003) and (Burton 2005) show that suppliers (i.e., technology sellers) experience greater collaborative wealth gains. (Johnson and Houston 2000) support this evidence for joint ventures as well as standard supply contracts. On the other hand, (Park and Kim 1997) indicate that joint ventures based on one-sided technology transfer lead to lower abnormal returns for the technology provider. Similarly, (Wang and Wu 2004) find buyers in vertical alliances experiencing greater valuation increases. Evidence on the direction of resource transfers thus appears contradictory. For instance, it may vary with the relative bargaining power of each party in a given context.

Third, larger scope of collaboration may hold greater value potential. Indeed, (Kim and Park 2002), (Vidal Suarez and García-Canal 2003) and (Chiou and White 2005) provide evidence that broader alliances, i.e., alliances spanning multiple businesses and/or countries, yield higher ARs. At the same time, scope benefits may be limited by increased transaction costs of collaboration (proposition 3.4). (Chiou and White 2005) support this notion by showing that multi-business alliances increase announcement returns, whereas comprehensive alliances (i.e., including all areas of business) have no such effect. More recently, (Higgins 2006) indicates that pharmaceutical firms earn greater ARs, when acquiring early rather than later stage R&D projects through collaboration. Alliance scope thus may be relevant, but remains too incompletely researched to constitute a necessary control, since the actual diversity of functional objectives has not been addressed.

Resource transfer (rather than generation), the direction of resource transfers, and the scope of collaborative activities thus may substantially affect the strategic value of alliances. The empirical findings, however, are too weak and too specific to consider these factors as necessary controls. Instead, they may they may present worthwhile avenues for additional research.

3.2.3.2 Structural Transaction Characteristics

Alliances are hybrid governance structures,[259] whose value depends on their congruence with transaction governance needs. In particular, asset specificity (proposition 3.1), environmental uncertainty (proposition 3.2), and transaction scope (proposition 3.3) may require more restrictive governance. At the same time, these conditions also provide for larger collaborative value potential (e.g., technology-related collaboration, which is associated with asset specificity).[260]

On an aggregate level, (Koh and Venkatraman 1991) and (Anand/Khanna 2000) show that JVs may be associated with larger ARs than contractual collaboration.[261] Similarly, empirical evidence suggests that equity alliances are more favorably perceived by the capital market [(Kale et al. 2002), (Kim and Park 2002), and (Chang/Kuo undated)]. These findings suggest that more restrictive governance schemes enable firms to realize the collaborative benefits more fully. Conversely, (Burton 2005) suggests that JVs may yield lower ARs. (Campart and Pfister 2003), (Piachaud and Muresan 2004), (Wang and Wu 2004), and (Chiou and White 2005) provide inconclusive findings.

As JV or equity-based governance not consistently outperform contractual alliances, the rapport of governance structures and transaction context may be the main source of collaborative value creation. For instance, (Koh and Venkatraman 1991) and (Piachaud and Muresan 2004) indicate that technology-related collaboration yields higher returns if they supported by

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259 In their ground-breaking work, (McConnell/Nantell 1985) highlight the difficulties of comparing joint ventures and M&A transactions, but argue that their returns on investment are similar. While a direct comparison of the extremes remains difficult due to differences in scope and logic (e.g., M&A transactions reflecting governance transactions in the market for corporate control), intermediate forms have been extensively researched.

260 Table 67 of the appendix provides an overview of the evidence on structural alliance characteristics. Table 68 discusses similar evidence for M&A transactions.

261 Similarly, (Arend 2004) finds (implied) stock volatility to decline in transactions organized as JVs rather than in contractual collaboration.

equity investments or organized as a JV. Contrarily, (Wu and Wei 1998) observe no significant differences in the ARs for research JVs and contractual R&D. Evidence on the value impact of equity-based governance in technology collaboration thus is not fully persuasive.

Finally, more extensive control rights (i.e., larger ownership stakes) may be associated with larger wealth gains [e.g., (Merchant/Schendel 2000), (Schut and Van Fredrikslust 2002)].[262] (Park and Kim 1997) assert that this effect less pronounced for larger firms. This may suggest that larger firms are less affected by environmental uncertainty (see subsection 2.3.1.2).[263] Moreover, (Higgins 2006) suggests that the value impact of control over collaborative ventures may vary with the type of control rights held.[264]

Overall, the evidence on heterogeneous value creation for JVs/equity-based and contractual collaboration is diverse. While JV formation and equity stakes may allow to enter into high-value (e.g., technology) collaboration, which would otherwise be at risk of opportunistic behavior (e.g., due to asset specificity), this value-creation potential may not always be realized.

Control 11:	The valuation effects of JVs and equity-based collaborative agreements may differ substantially from purely contractual ones.

[262] (Merchant 2002) also finds that unequal ownership increases JV value, however, regardless whether focal firms' take majority or minority stakes. This may indicate that the main benefits of dominant control stem from improved JV management, rather than the restriction of opportunistic behavior.

[263] Conversely (Anand/Khanna 2000) observe significant differences in JV and contractual ARs in absolute terms, but not when considering percentage returns. This would indicate that firms with a larger absolute market value stand to gain more from relying on JVs to control for opportunistic behavior and to provide coordination advantages.

[264] Specifically, (Higgins 2006) oberserves different valueation effects of intellectual property rights, exit rights, licensing rights, and manufacturing rights based on contract information included in the ReCap database for alliances between 1993 and 2000. This approach, however, does not adequatly reflect the information actually available to the capital market at the time of announcement. Specifically, some contractual details are often not reported in the initial announcements of alliances, but later added to databases such as ReCap.

3.2.3.3 Financial Transaction Characteristics

The financial implications of strategic alliances and JVs have been largely neglected in prior research (see Table 69 of the appendix for an overview[265]). In addition to their economic (i.e., cash-flow) impact, the extent of inter-partner payments may have a significant signaling value. Specifically, the financial commitments 'principals' to their 'agents' may reflect (limited) information asymmetries (proposition 4.2 in subsection 2.3.2.2)

First, the necessity of committing financial funds [(Burton 2005)] as well as the extent of these commitments [(Chen/Hu/Shieh 1991)] appear to negatively affect collaborative value. This is in line with the general notion that required investments c.p. reduce firm value. Relative to firm size, however, this effect becomes insignificant [(Chen et al. 2000)] or even positive [(Jones and Danbolt 2004)[266]], suggesting that larger firms may be less affected by the negative impact of collaborative investments.

Second, the direction of financial payments between the collaborating parties has been subject of research. Evidence suggests that the recipient of equity investments [(Park and Martin 2001)] or other financial flows [(Campart and Pfister 2003)] earns significantly higher ARs than the respective donor [(Wang and Wu 2004), (Häussler 2006)]. Similarly, (Jones and Danbolt 2004) find that the share of a firms' contribution to overall investments reduces its collaborative value. The focal firms' net financial gains thus are positively related to collaborative value creation. Additionally, incoming payments may serve as signals for unobservable firm quality (proposition 4.2), whereas collaborative investments may be inefficient due to managerial discretion (proposition 4.1).

Control 12:	The direction and extent of financial payments may affect the value created by collaborative agreements.

[265] Acquisition financing has been considered more extensively. In addition to the 'investment volume' reflected in the (relative) size of the acquisition target, the method of payment used for a given acquisition (i.e., cash or acquiring firms' shares) has substantial implications for the corresponding capital market reaction (see Table 70 in the appendix).

[266] However, (Jones and Danbolt 2004) only study JVs entailing capital investments. Consequently, any negative impact connected to the mere requirement of investing funds will not be reflected in this result.

3.3 Summary and Discussion

Based on the preceding review of value-related evidence, the present subchapter discusses the state of this stream of research and presents avenues for extending it.

3.3.1 Achievements and Limitations of Alliance Event-Study Research

Event studies on the formation of JVs and contractual alliances has demonstrated their value-generation potential (subchapter 3.1). Additionally, various factor may influence the specific value creation and appropriation. In this context, the preceding analysis has distinguished between environmental, firm, and transaction-level characteristics (sections 3.2.1-3.2.3). Together, these findings provide a considerably detailed albeit not entirely conclusive picture of collaborative value creation. The main insights support the complementarity of the theoretical perspectives presented in chapter 2:

- Evidence on the environmental level most strongly indicates that relatedness is an important antecedent of collaborative value. In particular, alliances involving horizontally or vertically related firms may provide strategic cost or positioning and facilitate technology-related market entry. Moreover, alliances addressing technological rather than marketing or production issues exhibit high collaborative value, which may equally reflect an alignment of R&D incentives for firms otherwise competing for innovations or profiting from involuntary knowledge spillovers. These findings support the market-based rationale proposed in section 2.2.1, with the exception of market-power arguments (proposition 1.1). Neither industry concentration, horizontal relatedness, nor firm size consistently yield higher alliance value that could reflect collusive benefits.
- On the firm level, access to the technological, commercial, and social resources of partner firms appears to be a substantial driver of collaborative value, even more so than additional resource creation. Furthermore, alliance experience may be essential in realizing these benefits. These findings support the notion than firm resources are at the root of strategic collaborative benefits.
- While market- and resource-based factors are prerequisite for collaborative value creation, evidence suggests that the high-value alliances may need to be supported by formal cooperative structures. Equity-based and JV governance appear to yield particularly great benefits in technology-

related collaboration. Similarly, prior relations among collaborating firms may present similar benefits. These findings endorse the assertions of TCE and agency theory with regard to inter-partner relations.

- In line with agency theory, information asymmetries at the firm level may equally affect collaborative value. On one hand, the significant influences of firm-level information complexity, firm size, and financial payments to focal firms indicate that alliances may hold significant value as signals of firm quality vis-à-vis capital markets. On the other hand, the not uniformly positive value impact on JVs and its significant connection to firm-level ownership structure reflect agency conflicts between firm management and shareholders.
- Finally, the evidence on capital-market conditions may denote that environmental dynamics affect the collaborative value-creation potential. Similarly, the variation in value impact across firm size and profitability may signify a substantial effect of firm development on collaborative benefits. These findings provide preliminary backing for the dynamic perspective on strategic alliance.

In summary, the existing event-study literature on alliance and JV formation effectively purports a complex mechanism of collaborative value creation incorporating all five theoretical perspectives: Market- and resource-based factors determine the overall value-creation potential, which is also moderated by environmental conditions and firm development. The actual value of a collaboration results from the value potential after accounting for the downsides associated with intra-alliance and managerial opportunism. Additionally, alliances may hold a signaling value, which is additive to its substantive one.

While the collection of previous event studies thus has documented substantial value creation and identified various value drivers, some important shortcomings remain. In particular, several theoretically founded propositions derived in chapter 2 have not been addressed sufficienty in a value-related context[267]

- Absorptive capacity (proposition 2.5) and transaction scope (proposition 3.3) are well established concepts in alliance research and may modify

[267] As a recent exception, (Higgins 2006) addresses some of these aspects from the perspective of pharmaceutical firms (i.e., the standard alliance partners of biotechnology firms). In particular, he considers the value impact of R&D intensity (positive), the extent of contractual control rights (negative, marginally significant), and compensation models (significant). At the same time, the study by (Higgins 2006) fails to comprehensively capture the industry context (i.e., specific alliance characteristics) and has methodological flaws (see FN 264).

the value implications of partner resources and transaction structures. Transaction scope has only been briefly touched upon by prior event studies (without, however, explicitly considering its transaction-cost implications). Absorptive capacity even has been neglected altogether.

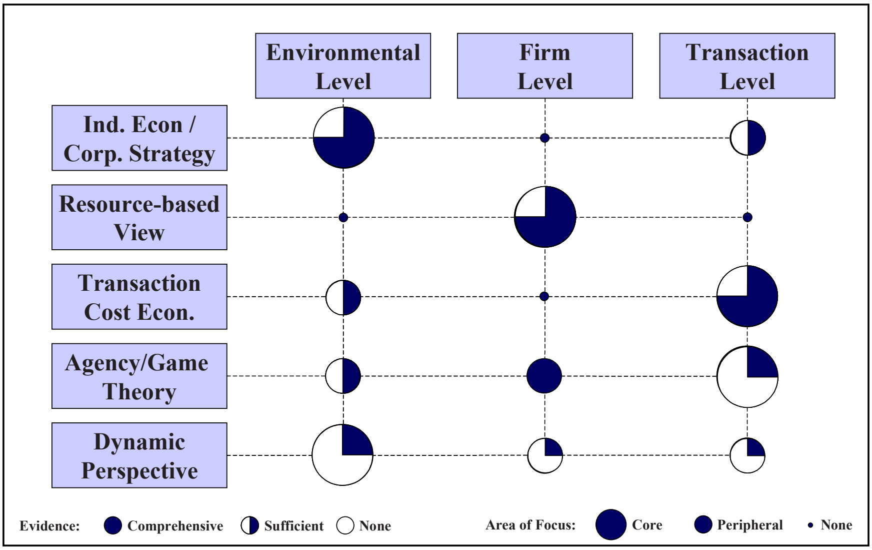
- Contractual control represents an important mechanism to dispel agency conflicts (proposition 4.3). In particular, information on compensation schemes and contractual features may affect substantive benefits and may signal the existence of inter-partner information asymmetries (propositions 4.2). However, prior event-study research has largely ignored contractual provisions, aside from the impact of inter- equity investments (Control 11) and partner payments (Control 12).
- The dynamic context of a collaboration may substantially modify its value-creation potential (propositions 5.1-5.4). With the exception of general capital-market conditions, have not been explicitly considered at either environmental (e.g., uncertainty) or firm (development) levels in a value-related context. Similarly, prior research has focused on alliance formation and termination announcements rather than addressing the overall evolution of collaborative value along the alliance life-cycle (proposition 5.5).

Given their general prominence, all three aspects deserve further attention. In summary, Figure 15 illustrates the achievements and shortcomings of the existing alliance event-study literature.[268]

[268] Table 71 of the appendix presents a more detailed overview of the evidence discussed in the present chapter. Specifically, state of research for each proposition was assessed in terms of its extent and consistency. Then, these assessments were aggregated into the environmental, firm-, and transaction-level dimensions (see Table 72 of the appendix).

This exercise furthered additional shortcomings, i.e., other propositions not explicitly addressed in prior event-study research. Most of these, however, are implicitly comprised in the derived controls. For instance, patent protection (proposition 4.5) is industry-specific and thus is reflected in Control 1. Table 73 in the appendix provides an overview of additional shortcomings not further elaborated in the present study.

Figure 15: State of Prior Event-Study Research



Own Illustration

In addition to the outright omission of certain factors, the validity of the inferences drawn from the reviewed findings may be limited. Specifically, the demonstrated relevance of certain environmental, firm, and transaction factors may be subject to causal ambiguity and inconsistency or incompleteness.

First, while all are linked to the theoretical perspectives discussed in chapter 2, most are associated with multiple strategic or economic rationales. For instance, value created by collaboration between related partners might reflect market power (proposition 1.1) or vertical quasi-integration (proposition 1.3/1.5) as well as improved inter-partner learning (proposition 2.5) or reduced ex ante information asymmetries (proposition 4.2). Future research thus may have to distinguish the specific sources of collaborative value, e.g., by employing less causally ambiguous proxies.[269]

Second, for some influences, evidence is either incomplete or inconsistent across various studies. For instance, international and intercultural aspects appear to be relevant, but findings are highly contradictory with regard to their specific impact. Similarly, the absolute effect of JV or equity-based collaboration (relative to contractual ventures) could not be estab-

[269] Note that general alliance research has distinguished specific variables for technological similarity (learning context) or buyer-supplier-relations (vertical integration) in order to avoid overreliance on SIC codes.

lished. Evidence regarding the direction of resource transfers (i.e., 'buyer' versus 'supplier' roles) still is too scarce and unconvincing. Additional research may help clarify these issues. In particular, controlling for the specific context or focusing on less heterogeneous settings may diminish potentially confounding (e.g., industry- or country-specific) effects.

In conclusion, prior event-study research on alliance formation has documented diverse value influences. Although their impact may reflect multiple theoretical arguments and does not always exhibit the desired consistency across different studies, these value drivers need to be controlled for in future research endeavors. Additionally, comparing the value-related evidence to the theoretically founded propositions from chapter 2 allowed identifying several shortcomings, which may be addressed by future research.

3.3.2 Hypotheses for Original Empirical Research

The present study set out empirically to empirically account for (a) the plethora of possible influence on collaborative value in general, (b) its specific drivers in the European biotechnology setting, and (c) the dynamic influences on the value of these alliances (see section 1.2.1).

The preceding reviews of general and value-related alliance research have elaborated on the various general factors affecting collaborative value creation (a) and identified 12 influences that need to be controlled for. The documented shortcomings in the existing alliance event-study literature and the specific characteristics of biotechnology collaboration suggest that additional value drivers may need to be considered.

This section thus aims to derive hypotheses regarding the value impact of biotechnology alliances (b) and dynamic influences on collaborative value creation in this setting (c). Congruent to the discussion of prior event-study evidence, it first addresses the overall value impact of alliance-related news, then proceeds to the specific value drivers.

3.3.2.1 Hypotheses Concerning Aggregate Value Impact

The evidence presented in sections 3.1.1 and 3.1.2 has documented significantly positive valuation effects of strategic alliances and domestic joint ventures. Studies in other high-growth settings [e.g., (Neill et al. 2001), (Park et al. 2004)] also observe particularly high collaborative gains. Combined with the evidence that technology-related collaboration tends to earn above-average ARs (subsection 3.2.3.1), this nourishes the expectation that biotechnology alliances should have significantly positive value impact.

Hypothesis 1:	The abnormal returns to strategic alliance (and JV) formation are significantly positive.

Prior event-study evidence on the termination of collaborative ventures is mixed (section 3.1.3), in particular showing a potential for wealth gains, when collaborative ventures are bought-out or sold-off. However, the mere discontinuation of alliances may reflect nonperformance or inter-alliance rivalry (proposition 5.5b) and appears to consistently hurt firm value. Excluding internalization or external sale, alliance termination thus should lead to significantly negative abnormal returns in biotechnology alliances.

Hypothesis 2:	The ARs to announcements of alliance (or JV) termination are significantly negative.

Aside from alliance formation (Hypothesis 1) and termination (Hypothesis 2), no other events along the alliance lifecycle have been studied in an event-study context. Yet, such intermediate steps may reflect the evolution of collaboration and the successive disclose of value-related information to the capital market.

As suggested by proposition 5.5a, the adaptation as well as progression of an existing alliance may reflect successful (re)alignment of the alliance with company objectives and environmental requirements. Given that firms tend to adapt their alliances activities to changing technological and market development (propositions 5.1/5.2), such a realignment may further increase the alliance's value. Moreover, firms may particularly adapt or expand well-performing alliances (e.g., by securing commercialization rights), such that adaptation announcements may also signal collaborative success.[270]

In addition formal restructuring of alliance terms, collaborative value may continuously evolve over the duration of an alliance. Announcements relating to alliance operations thus may update the market's assessment of collaborative benefits and thus affect firm value. Similarly, prior research has documented significant valuation effects for announcements of technological progress, including R&D activities [e.g., (Chan et al. 1990)], patenting [e.g., (Austin 1993)], and new product introductions [e.g., (Chaney

[270] In this context, the internalization of successful collaborative projects (proposition 5.5c) may be considered as an expansive form of alliance adaptation. As such events are rare in the biotechnology setting, internalization will not be considered separately.

et al. 1991), (Sharma and Lacey 2004)].[271] As these indicators may reflect improved competitiveness (e.g., successful market entry ~ proposition 1.3), they are generally associated with positive effects on firm value [see (Brockhoff 1999) for a review and summary]. Consequently, the progression of an alliance, i.e., the achievement of milestones and the commencement of new activities, should increase firm value.

Hypothesis 3:	Announcements of alliance adaptation and progression exhibit significantly positive ARs.

3.3.2.2 Hypotheses on Biotechnology-Specific Alliance Characteristics

The attempt to understand the industry-specific value drivers in biotechnology collaboration starts with their strategic logic. However, the functional objective of a collaborative venture is the only such aspect extensively considered in prior research (Control 10).

As a point of departure, Section 1.3.1 highlighted three main aspects of the biotechnology industry: The drug development process, distinct business models and the function of DBFs as suppliers of innovations to Big Pharma. These may serve to devise a typology of biotechnology alliances and substantially affect their value potential. In particular, these factors include the business model pursued in collaboration, the developmental stage of the relevant project, and role of the focal firm vis-à-vis its partner(s).

First, collaboration during earlier or later stages of the drug development process may serve substantially different functions with regard to corporate development (also see proposition 5.4 in subsection 2.4.2.2). The main function of exploration alliances is to produce innovations and thus lay the groundwork for commercialized products and exploitation alliances.[272] Conversely, exploitation alliances allow firms to capitalize on innovations, e.g. existing product candidates (or buy into other firms' successful product development).[273] As the greatest bottlenecks to DBFs appear to lie in

[271] (Liu 2000) distinguishes aggregates six types of innovation-related news announcements and documents significantly positive announcement ARs, but negative long-run returns (BAHR).

[272] While (Rothaermel and Deeds 2004) only refer to exploration and exploitation (i.e., early and late stage) alliances, alternative distinctions may be used (see subsection 4.2.1.2).

[273] Some prior event-study evidence (see subsection 3.2.3.1) also suggests that leveraging existing (partner or focal-firm) resources may be more valuable than the creation of new ones. However, 'pure' collaborative R&D alliances (i.e., not building on existing resources) are rare in biotechnology, since firms

the areas of clinical development and commercialization (see subsection 1.3.2.1), the benefits of exploitation alliances should exceed that for earlier-stage collaboration. In particular, publicly listed DBFs generally possess internal know-how and products (or product candidates), but may be challenged to finance advanced-stage trials or to establish proprietary sales forces.

Hypothesis 4:	Exploitation alliances are associated with higher ARs than exploration alliances.

Second, European biotechnology alliances may address different business models. Their value may vary across business models, since these differ in their economic implications [see subsection 1.3.2.1]. In particular, drug discovery requires extensive investments with technologically and commercially uncertain outcomes. To offset these risks, enormous profits may be realized, when commercializing patent-protected drugs. Drug-discovery collaboration thus may be valuable by helping advance such projects, gaining access to complementary resources (e.g., established distribution channels), or providing financial resources for further R&D activities. At the same time alliances serve to commercialize platform technologies and provide service, yielding immediate payoffs.[274]

In comparison to the drug-discovery business model, the value potential of technology and service provision may be limited and they may best serve as complementary activities to finance further internal R&D [cf. (Fisken and Rutherford 2002), (Anonymous 2003)].[275] Alliances strengthening the drug-discovery pipeline or building on proprietary drug candidates can thus be expected to yield higher collaborative gains than technology or service alliances.

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usually contribute complementary technologies to joint drug discovery. Consequently, the distinction of resource creation and transfers would be muddy and difficult to implement in this context.

274 All of these examples relate to the traditional collaborative structure, in which DBFs share their drug candidates and platform technologies with Big Pharma firms or provide services. Conversely, they may also collaboratively insource to bolster their internal R&D efforts. The main sources of collaborative value then reside in the access to new drug candidates or the benefits of applying advanced technologies and services to the proprietary drug pipeline.

275 Specifically, the value-added of. Additionally, the position of the shareholders as owning long call-options on residual firm value [e.g., (Brealey and Myers 2000)] suggests that the high-risk high-reward profile may increase the attractiveness of the drug discovery business.

Hypothesis 5:	Collaboration addressing (proprietary) drug-discovery yields higher AR than collaboration associated with other business models.

Third, the relative contributions of each alliance partner may have a significant influence on collaborative value and on the distribution of the created value. Prior event-study research has provided some contradictory findings on the direction of resource transfers (see subsection 3.2.3.1). The value available to 'buyers' and 'suppliers' in collaborative ventures thus may differ across contexts.

Collaboration, in which DBFs supply drug candidates, services, or technologies to Big Pharma firms or other partners, represents 'outbound' resource transfers. As such alliances provide DBFs with the financial means for needed further company development (subsection 1.3.2.1), they should be associated with significant wealth effects. At the same time, 'inbound' alliances may attract complementary technological resources further strengthening DBFs' technological bases. As such collaboration, however, do not address the main needs of DBFs, they should on average yield lower wealth gains than 'outbound' alliances.

Hypothesis 6:	Alliances designed to leverage and capitalize on internal technological resources (i.e., 'outbound' direction of resource transfer) are associated with higher ARs than ('inbound') alliances attracting further resources.

Together with the functional alliance objective (Control 10), the three presented biotechnology-specific transaction parameters describe the specific context of each alliance. As hypothesized, each may affect value creation either in isolation or in conjunction with the other dimensions.[276]

3.3.2.3 Hypotheses Regarding Compensation Structure and Contractual Provisions

The traditional role of DBFs providing their products and services to alliance partners (in particular Big Pharma firms) constitutes an agency relationship, since the latter (as principals) possess limited information on the quality of the DBFs (agents) and their resources. Such information asym-

[276] The present study does not formulate explicit hypotheses regarding possible interaction effects. While the three primary effects hypothesized here may clearly moderate or mediate each other, Hypothesis 4 to Hypothesis 6 also extend to the aggregate effect of each transaction dimension. In such cases, timewise limited collaboration may not even proxy for increased agency conflicts.

metries may reduce collaborative benefits (proposition 4.2). Contractual control may alleviate agency conflict and thus facilitate collaborative value creation (proposition 4.3a). At the same time, the uncertainty associated with biotechnological R&D may create substantial incomplete-contracting problems (proposition 4.3b). While contractual alliance features thus may be quite relevant in the biotechnology setting, their value implications have not yet been analyzed, possibly due to limited public availability of such information at the time of announcement. The present thesis addresses the value impact of three contractual constituents that are frequently included in alliance formation announcements: The structure of inter-firm payments, time-limited collaboration, and the use of contractual flexibilities.

First, the structure of compensation payments may resolve potential agency conflicts between collaborating firms. Similar to the use of convertible securities in VC financing [e.g., (Kaplan and Strömberg 2004)], conditional payments may reduce the informational disadvantages of principals and ensure agents' cooperative behavior. The efficient allocation of collaborative ownership rights may also help circumvent incomplete-contracting problems [cf. (Robinson and Stuart 2002), (Grossman and Hart 1986)]. In particular, milestone and royalty payments let the DBFs participate in the eventual pay-offs from the collaboration and should thus be associated with superior valuation effects relative to fixed payments.[277]

Hypothesis 7:	The use of milestone and royalty payments increases collaborative value creation.

Second, alliance duration may be restricted to contain the impact of information asymmetries and induce cooperative behavior. More generally, theoretical literature has proposed staged investments as a means to mitigate agency conflicts in settings such as venture capital [e.g., (Gompers 1995)]. Similar to limited transaction scope (proposition 3.3), a limited-time agreement may be especially suitable under conditions of high uncertainty. The time-limitedness of collaboration may indicate high agency costs and is not free of costs. Effectively, it represents a second-best solution, similar to extensive contractual control rights (proposition 4.3a in subsection 2.3.2.3). As such, the value impact of time-limitedness should be negative in comparison to open-ended collaboration.

[277] Alternatively, such payments may be associated with distinct types of collaboration, for instance, drug-discovery alliances. However, the differences in payments across different business models may be more strongly associated with the extent of payments (e.g., % of sales to be paid as royalties) rather than use of a certain type of payment [cf. (Finch 2001)].

Conversely, the (expected) duration of an alliance is positively related to inter-party trust, which in return reduces agency costs and may facilitate alliance contracting (propositions 4.4a and 4.4b in subsection 2.3.2.3). The substantive value of collaboration may also increase with duration, assuming a constant intensity of collaboration over time. As a consequence, the effect of time-limitedness on collaborative value should therefore not be homogeneously negative.

Hypothesis 8:	Limit duration of collaborative agreements decreases announcement AR, with the duration itself having a value-increasing effect.

Third, as explicit contracting may prove inadequate in situations characterized by high environmental uncertainty, contingent control rights can be used instead (proposition 4.3a in subsection 2.3.2.3). These allow firms to maintain the flexibility of reacting to post-formation developments. (Hellmann 1998) discusses the use of similar control rights (e.g. rights to replace the founder) in VC financing. Additionally, contingent control rights in alliance contracts may signal agent quality, since high-quality DBFs stand to loose little from granting such rights to their partners [cf. (Dessein 2004)].

In a highly uncertain setting, such as the biotechnology industry, explicit contingencies thus should be associated with increased collaborative value creation. These may include contractual flexibilities to expand, extend, alter, or abort collaboration at the option owner's discretion or given the occurrence of pre-determined events.

Hypothesis 9:	Explicit flexibilities in alliance contracts have a positive impact on announcement AR.

Hypotheses 7-9 represent a first attempt at considering the value impact of contractual alliance features based on the information available to the market upon announcement. These as well as the control for equity-based transaction governance (Control 11) treat both parties equally, although one partner (e.g., Big Pharma) may be the principal, with the other (e.g., small biotech) being the agent, which assumes that transaction or agency costs are shared by both transacting parties (e.g., by the principal adjusting the financial compensation for the agent depending on the contractual provisions).[278]

[278] Truly equal collaboration,where principal and agent cannot be clearly identified (or rather: where each party is both principal and agent), also exist. Such agreements would not fit into a framework distinguishing the value impact of

In deriving the hypothesized effects, the reasoning focused on the efficiency-improvements associated with the respective contract component. Additionally, they convey signals with regard to inter-firm relations, which may reinforce or countervail the direction of the proposed impact. For instance, collaboration exceeding one technological lifecycle may reflect a positive appraisal of partners' innovation ability. Conversely, the use of contractual flexibilities may hint at the existence of agency conflicts.

3.3.2.4 Hypotheses Regarding Environmental Dynamics and Firm Development

The third main intent of this study is to analyze the impact of evolving environmental conditions and firm development on the value impact of strategic alliances (see section 1.2.1). So far, only the influences of the general market context (Control 4) and firm size (Control 5) on collaborative ARs have been considered. The present thesis extends this quest to other environmental forces (alliance activity, environmental uncertainty), the bearing of firm development for the mechanisms of collaborative value creation, and potential self-selection effects.

First, alliances may allow firms to achieve or maintain privileged positions in evolving collaborative networks (proposition 5.1b in subsection 2.4.2.1). In reaction to or in anticipation of events altering the status-quo of competition, firms may need to collaborate to avoid being left behind, which in return may lead to an avalanche of transactions. Firms not sufficiently collaborating in an environment mandating such activity may suffer from adverse performance effects. Consequently, the overall activity in the market for corporate alliances (or inter-firm transactions in general) may be positively related to the value impact of a given alliance.[279]

Hypothesis 10:	The level of inter-firm activity at the industry level is positively related to the abnormal announcement returns on alliance formation.

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transaction governance and contractual provisions on the principal from that on the agent.

[279] As alliances and M&A may be strategic alternatives for adapting to changing environmental conditions [e.g., (Hagedoorn and Duysters 2002a)], intense M&A activity may equally increase collaborative benefits.
Finally, from an institutional perspective [cf. (Meyer and Rowan 1977)], collaboration may particularly support the legitimacy of a firm, when the market for collaborative activity is 'hot'. This may further ameliorate the market responses to alliance formation.

Second, firms may especially benefit from the flexibility inherent in alliances under conditions of exogenous uncertainty (proposition 5.2 in subsection 2.4.2.1). In particular, the flexibility value of collaboration varies the volatility of its underlying value.[280] The volatility of the biotechnology sector as a whole may reflect the components of the underlying's volatility common to all biotechnology collaboration. Market-level volatility thus reflects market risk as well as average technological and collaborative uncertainty. Although the latter two may be in part specific to the individual alliance, aggregate volatility should be an adequate measure of environmental uncertainty. As such, it should be positively associated with collaborative value creation.

Hypothesis 11:	The average volatility of the biotechnology sector increases the value of interorganizational collaboration.

Third, only the direct effect of firms size has so far been considered as a determinant of abnormal returns (Control 5). Moreover, firm development may affect the value contribution of certain alliance types (proposition 5.4 in subsection 2.4.2.2). In addition to the feedback-effects of exploration and exploitation alliances on firm development, this may generally extend to collaborative value-creation mechanisms. For instance, smaller firms may benefit from gaining access to otherwise unattainable resources. Similarly, they may more extensively gain from the signal associated with reputable alliance partners. Conversely, such firms may be disadvantaged in terms of bargaining power when collaborating with larger partners.

As the preceding controls and hypotheses addressed the relatively young and still developing European biotechnology sector in general, these effects should be should even more pronounced for smaller firms.

Hypothesis 12:	Valuation effects of collaborative agreements will be stronger and more clearly associated with the above hypotheses.

Fourth, non-random alliance formation may constitute a self-selection bias. On an organizational level, (Arend and Amit 2005) observe that accounting for self-selection affects the performance implications of corporate alliances. As high-performing firms tend to collaborate more frequently, the

[280] Note that other value drivers of such options may be either directly (e.g., value of underlying) or indirectly (e.g., time-value of money) considered as part of the standard influences being controled for. Similarly, the extent of competitive market activity may reduce the time to expiration of the options (i.e., the risk of alliances becoming moot due to competitors superior achievements), which would work counter to the effect hypothesized in Hypothesis 10.

(nonetheless positive and significant) effect of alliance activity may be overestimated.[281]

As the extensive review of alliance literature in chapter 2 showed, similar factors may determine alliance formation and performance. Consequently, the value impact of environmental and firm-level influences may be direct (as hypothesized above) or mediated by alliance formation. In this context, (Ahuja 2000b) notes that overlapping drivers of alliance formation and performance may lead to oversampling, i.e., more observations exhibiting a given characteristic. Given the generally positive effects of collaboration, drivers of alliance formation may be mistaken for drivers of alliance performance.

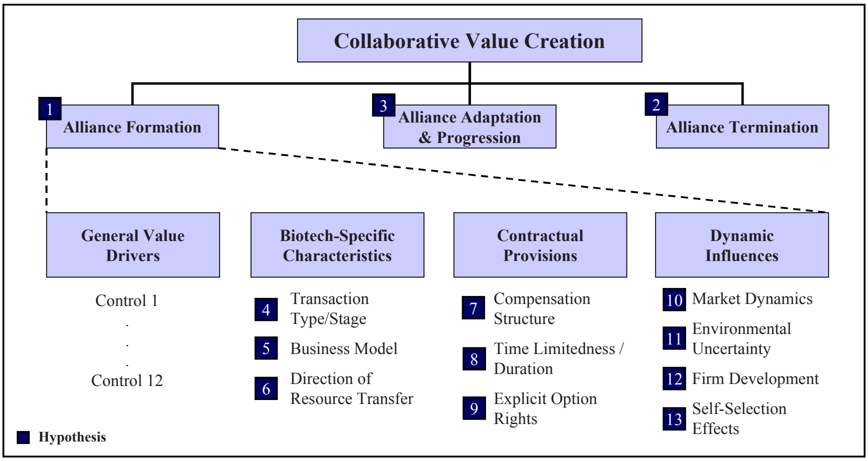
Hypothesis 13:	Self-selection in alliance formation may mediate the value impact of environmental and firm-level variables.

The hypotheses derived in this section present the four substantive innovations pursued in the empirical part of this work: The evolution of collaborative value along the alliance lifecycle (hypotheses 1-3), the value impact of biotechnology-specific alliance characteristics (hypotheses 4-6), contractual features (hypotheses 7-9), and dynamic influences (hypotheses 10-13), i.e., environmental dynamics and focal firm development as well as self-selection effects. Together with the controls for generally relevant value drivers, these hypotheses allow for a comprehensive assessment of collaborative value creation.[282] Figure 16 presents a graphical overview.

[281] As (Arend and Amit 2005) study the impact of alliance activity on firm value and accounting performance on an annual level, this overall self-selection effect does not apply to announcement returns. However, it illustrates the selective nature of alliance formation and its implications for collaborative value.

[282] **Table 74** in the appendix shows all 13 hypotheses at a glance. Two additional aspects were found to be neglected in prior event-study research (see section 3.3.1), but did not fall into the scope of the present thesis as defined by its research objectives (see section 1.2.1): The value impact of absorptive capacity and transaction scope. Both were empirically assessed, but gain no particular support, when accounting for standard controls (see Table 171 to Table 173 of the appendix). Their omission in the main analyses thus does not constitute a substantial bias.

Figure 16: State of Prior Event-Study Research



Own Illustration

4 Data and Empirical Methodology

"Science arose from poetry –
when times change the two can meet again
on a higher level as friends."

Johann Wolfgang von Goethe: *Morphology*

This chapter outlines the procedures and methodologies employed as part of the empirical study.[283] In doing so, it pursues a two-fold mission. First, details the approach taken in the present research project, including the choices made with regard to alternative data sources, statistical procedures etc. Second, it provides an overview of the data used in later analyses and specifies the relevant data characteristics, which helps to avoid a lengthy discussion of variables in the subsequent section. In sequence, it addresses the overall sample selection procedure (4.1), data coding (4.2), as well as event-study (4.3), and cross-sectional methods (4.4). Moreover, this chapter sheds some light on empirical specificities of the European biotechnology section, including a formal assessment of industry definition (subsection 4.1.1.2) and a time-series analysis of DBF stock returns (section 4.4.2).[284] Subchapter 4.6 concludes.

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[283] As reference, Table 75 provides an overview of the methodologies used in prior alliance-related event study research. Table 76 extends this to other value-related research.

[284] The results of these analyses were presented at the 6th European Conference on Health Economics (July 8th, 2006) under the title 'The European Biotechnology Industry – Assessment and Research Propositions' (No. P68/482). The author would like to expresses his gratitude for comments received from conference participants. All remaining errors and omissions are solely the author's responsibility.

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4.1 Sample Selection

In the context of the present work, sample selection faces two distinct challenges. On one hand, the definition of European biotechnology firms is rather fuzzy. On the other hand, event announcements have to be gathered for all sample firms in a valid and reliable fashion.

4.1.1 Identification of Focal Firms

4.1.1.1 Available Classifications and Prior Research

So far, no universally accepted listing of European biotechnology firms exists, as evidenced by substantial differences in the firms included in standard industry publications, such as Biocentury's "The Bernstein Report®", BioScan, BioVenture View, the annual Ernst&Young biotechnology industry reports, or Recombinant Capital.[285] Given the historical predominance of the U.S. biotechnology sector, these industry publications are primarily focused on the U.S. market. As their validity for the European market may vary, simply following the precedents of prior research would be ill-advised. Furthermore, prior academic research has not even in the U.S. used these publications consistently. While the enjoy Bioscan and Recombinant Capital enjoy the great acceptance in previous studies, they are commonly used together or in conjunction with other information sources.[286]

In addition to these standard industry publications and databases, a variety of other sources provide industry classifications for European biotechnology firms. These most prominently include industry association membership directories and stock-exchange listings.[287] Their validity as a foundation for empirical research may benefit from their European focus. Conversely, association members may also stem from outside the actual industry, including Big Pharma firms, research institutes, conglomerates with biotechnology activities and even consultancies or investment

[285] See Table 77 for descriptions of these publications. As shown in Table 78, prior academic research in the biotechnology industry has extensively relied on these sources.

[286] Table 78 of the appendix provides an overview of prior empirical research drawing on these and other sources for sample construction purposes.

[287] Numerous investment analysis and other firms also publish industry classifications of public companies (e.g., Euroland). In these cases, it is, however, nearly impossible to assess provider quality. Consequently, these sources are not included in the sample selection process.

firms.[288] Similarly, the classification regimes and information provided on industry affiliation vary substantially among stock exchanges.

Since no individual classification scheme can claim universal acceptance, sample selection directly based on any one (or multiple) sources would require excluding some firms as 'non-biotechnology' or face the risk of employing too broad a sample scope. To avoid such a judgment-call, the first step in the sample selection process aims at understanding the validity of potential industry sources (subsection 4.1.1.2). Based on this assessment and the consensus of valid classifications, a suitable sample of European biotechnology firms can then by derived (subsection 4.1.1.3).

4.1.1.2 Consensus Analysis of Industry Definitions

All seven publications and listings discussed above were searched and firms were marked as being included in any of the sources. A first screening yielded a total of 141 firms listed on European stock exchanges, which were considered as DBFs by at least one source.[289] As Figure 17 illustrates, this overall sample of firms thus cannot be regarded as following a generally accepted definition of the European biotechnology industry: (a) Individual listings include between 39 (28%, industry associations) and 109 (77%, Biocentury). (b) Only four of the 141 firms are included in all seven classifications and almost half (61) by no more than two sources.

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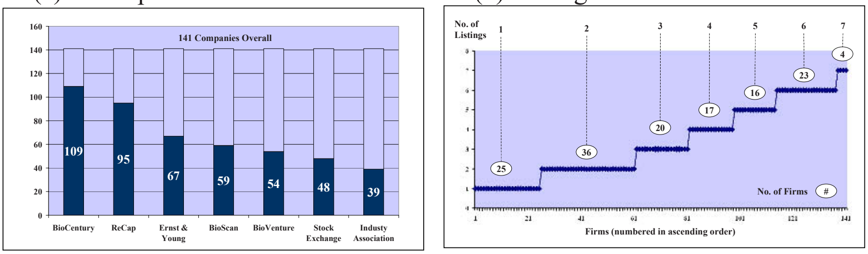
288 Note that industry association membership in general has been criticized as being a crude instrument for sample selection. In the context of the European venture-capital industry, for instance, (Çetindamar and Jacobsson 2000) find that association membership directories often include firms other than venture capitalists. Consequently, (Çetindamar and Jacobsson 2000) and (Farag et al. 2004), manually correct membership listings to arrive at suitable industry samples.
A more comprehensive compilation of biotechnology industry association members only became available after the sample selection process had been completed [cf. (Gabrielczyk and Damaschun 2005)]. Additionally, it apparently suffers from the same shortcomings as the national association directories, in particular the inclusion of obvious big pharma firms.

289 Table 79 breaks down this data across the different sources, i.e., the numbers of firms included in each listing and the overlaps between different listings. While the exact date of each publication/listing varies, the present work started considering the most recent listings at the end of the study period (December 31st, 2003), moving backwards in time as data availability permitted.

Figure 17: Overview of Classification Data

(a) Firms per Source (b) Listings Per Firm



Data Source: Own Analysis

In order to assess the validity of firm classifications, the present study proposes a consensus-based approach. Its underlying logic is as follows: If different industry sources classify a given company as belonging to the biotechnology sector, this consensus provides assurance of selecting the 'right' sample firms. Ideally, all classifications would match perfectly, yielding one generally accepted definition of European DBFs. As long as no perfect consensus exists, greater overlap in alternative classifications implies greater congruence (and validity of the individual information source).[290]

Following the notion of consensus, the contributions of the different publications to a consistent definition of biotechnology firms represents their relative importance and validity. Plainly speaking, sources providing highly consensual classifications provide the greatest service to a generally accepted industry definition. In order to compare and further analyze the degree of consensus between the seven individual classification schemes, the present study uses an analogy to network theory (see sub-section 2.2.2.2). Network centrality is positively and network efficiency negatively related to consensus.[291] Two indicators were constructed to capture the relative centrality and efficiency of each listing:

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290 This approach builds on the general concept of consensus as a "general agreement among the members of a given group or community, each of [whom] exercises some discretion in decision making" [(Annonymous 2007)]. While some applications, e.g. in computer science [e.g., (Fischer et al. 1985)] refer to perfect agreement, the present study is in line with general financial practices and research regarding consensus as the aggregate of individually diverging assessments [e.g., (Welch 2003)].

291 In the present context, network consists of the (seven) focal listings and all firms identified by any one source. As illustrated in Equations (20) to (22) of the appendix, the employed measures are derived from each listing's network centrality [measured using degree centrality as defined by (Freeman

- Equation (2) presents the centrality measure, indicating consensus between focal and alternative. It measures the average share of other listings' constituents also included in the focal source, i.e., the degree of overlap (embeddedness) the information source has with all others. A high consensus score expresses that a given classification has a strong impact on achieving overall consensus.
- Equation (3) reflects the efficiency of a given listing, but was reverse-coded to receive a measure positively related to consensus.[292] It quantifies the average share of the focal listing's constituency also included in other listings. A high efficiency score indicates that the listing contains few firms not included in alternative classifications, which again improves consensus.

$$C_j^A = \frac{1}{(J-1)} \cdot \sum_{j=1}^{J-1} \frac{k_{i \cup j}}{k_j} \qquad (2)$$

with J = Total number of listings

k_{iUj} = Number of firms included in both focal listing i and listing j

k_j = Overall number of firms included in listing j

$$E_i^A = \frac{1}{(J-1)} \cdot \sum_{j=1}^{J-1} \frac{k_{i \cup j}}{k_i} \qquad (3)$$

with J = Total number of listings

$k_{iUj\,j}$ = Number of firms included in both focal listing i and listing j

k_i = Overall number of firms included in focal listing i

In essence, a listing largely overlapping with multiple other sources (centrality) without having many non-consensual constituents (efficiency) best contributes to the overall level of consensus (network integrity).

1978/79)]. Consequently, centrality refers to the contribution of the focal information source to other listings' network, whereas efficiency refers to the focal listing's centrality being shared with other listings.

292 Note that the standard measure of network efficiency (i.e., non-redundancy of ties) suggests sources providing a larger share of 'unique' entries are 'better' (more efficient). With regard to the objective of the present analysis, however, such 'unique' entries would deter consensus.

The centrality and efficiency measures were separately calculated for all seven listings.[293] Figure 18 exhibits the results for each listing based on the overall sample 141 firms. These provide some valuable insights into the validity of the available DBF listings:

- The BioCentury directory is the by far most comprehensive source, comprising a large share of firms also included in other listings, as reflected in the highest centrality score of all information sources. Conversely, it scores low efficiency on the efficiency measure, i.e., a fairly large number of the BioCentury firms are not part of other listings. As a result, BioCentury constitutes a powerful building block, which, however, requires validation to avoid the risk of false inclusion. To a lesser extent, these observations also apply to ReCap.
- BioScan, BioVenture, and Ernst&Young are rather similar sources. All three exhibit lower (though still substantial) centrality and higher efficiency than BioCentury and ReCap. Consequently, they represent stabler bets, but lack the credence of the more 'central' listings.
- The industry association membership directories and stock exchange listings differ substantially from the other classifications, i.e., they lack the same degree of consensus as the industry-specific sources have amongst themselves. While their efficiency scores are similar to those of the industry-specific sources, their centrality measures are comparably low. This implies that they fail to compensate for their lack of breadth by providing a more coherent set of constituents.

Based on these general conclusions with regard to the listings' validity, the consensus analysis suggests that procedures building on the five industry-specific publications may lead to a high consensus and thus validity, whereas stock exchange and association membership listings should be eliminated as valid sources of industry classifications.

At the same time, no single source appears to appropriately reflect a generally accepted industry definition. Those listings extensively overlapping with others (Biocentury, Recap) also include large numbers of constituents not validated by others. That is, no clear evidence exists of individual industry-specific sources being preferable to others.[294]

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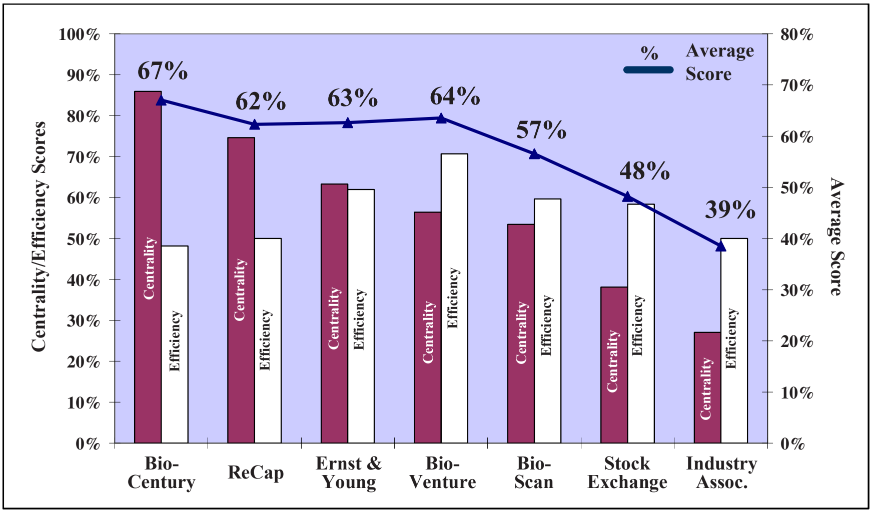
[293] Table 80 presents the centrality and efficiency measures for all seven listings.

[294] The sole case of one source dominating another with regard to both centrality and efficiency measures is BioVenture vis-à-vis BioScan. However, the difference in centality is marginal, and does not require BioScan (the most commonly used source of classifications in U.S. academic studies) to be eliminated from the sample selection procedure.

Figure 18: Completeness and Efficiency Scores of DBF Listings



Data Source: Own Analysis

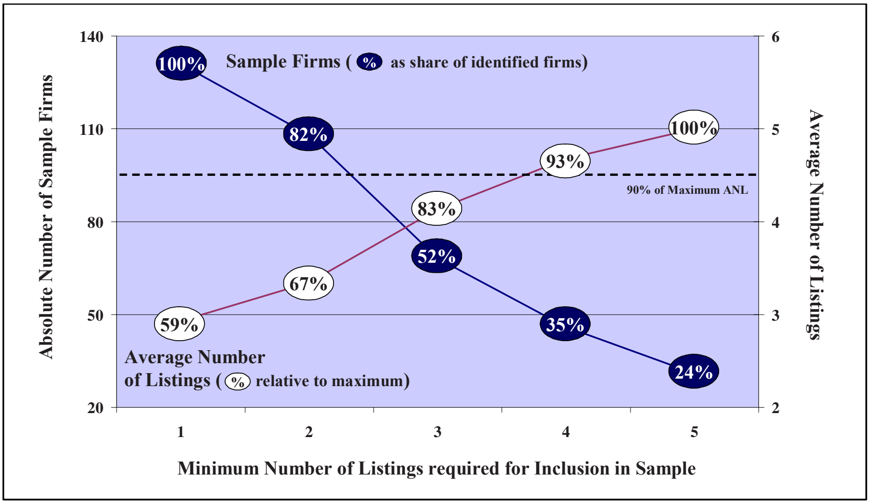
4.1.1.3 Consensus-Based Sample-Selection Procedure

Firms excluded from any one (valid) listing are not considered part of that source's underlying definition of the biotechnology industry. Therefore, firms included in multiple listings fulfill the requirements of alternative industry definitions, i.e., better fulfill the consensus objective. At the same time, the omission from any one listing may be equally flawed. Therefore, requiring undisputed inclusion in all classifications may potentially induce a type-2 error, i.e., relevant biotechnology firms not being included in the sample. Consequently, the choice of selection algorithm should consider both aspects.

Alternative selection algorithms were considered, requiring varying amounts of consensus for the selection of constituents into the final sample.[295] These cutoff-levels in the minimum number of listings range from 1 (i.e., all 131 firms included in any one of the five listing) to 5 (i.e., the 31 firms part of all five listings). Figure 19 presents the effects of different selection algorithms on the overall size of the final sample (i.e., number of firms included) and its consensus-based validity (i.e., the average of number of listings for each sample firm).

295 Table 81 presents an overview of the selection algorithms, their underlying rationale, and the corresponding indicators (i.e., number of firms included in sample and average number of listings).

Figure 19: Sample Characteristics for Alternative Sample-Selection Algorithms



Data Source: Own Analysis

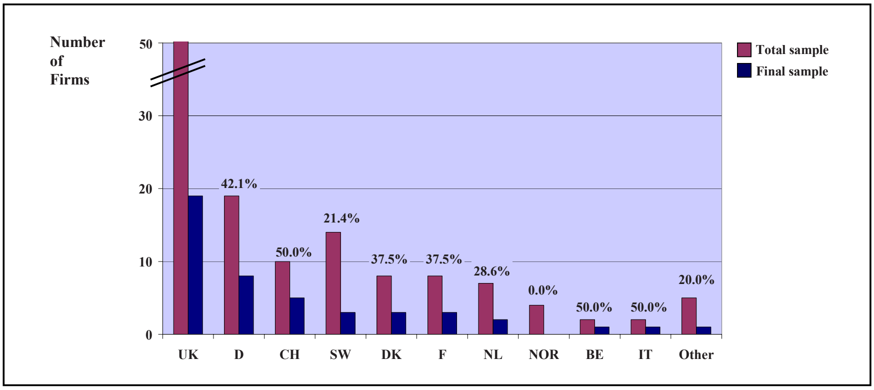
The comparison of alternative selection algorithms reinforces two general premises regarding the sample selection process: First, more restrictive selection algorithms increase the level of classification consensus. In particular, the average number of listings per sample firms steeply increases for medium levels of selectiveness (e.g., cut-off values of 3 or 4 listings). Second, the sample size declines rapidly for very high levels of required consensus. That is, while requiring high levels of overlapping classifications are be desirable from a validity-perspective, its benefits are limited by the disadvantages of small sample sizes. In order to achieve a significant level of consensus [i.e., over 90% of the maximum average number of listings per sample firm], the present study employs a rigorous algorithm requiring firms to be included in at least four out of five listings to be included in the final sample. While stressing sample validity, this approach also mitigates the potential risks arising from erroneous exclusions of firms from individual listings.

The consensus-based sample-selection procedure used in present study yields a sample of 46 DBFs considered core to the European biotechnology sector.[296] Overall, 35.1% of all firms included in any one classification

[296] Note that not all sample firms are public over the entire period of study. While firms going public during this time are not excluded from the sample, only events announced while public will be considered. Table 82 in the appendix provides an overview of the firms included in the final sample.

end up in the final sample. Figure 20 presents a cross-country comparison, indicating a generally homogeneous selection process.

Figure 20: Distribution of Sample Firms (and Exclusions) across Countries



Data Source: Own Analysis

Notable exceptions are Sweden and Norway, whose companies are underproportionally represented in the final sample. This may be especially due to the relatively early acquisitions of Norwegian (e.g., Amersham) and Swedish (e.g., Perbio) firms by larger, which may have resulted in them still being included in some listings, whereas they were excluded from the majority of sources.

In spite of the care taken in analyzing the sample selection process, a number of issues necessary to ensure the validity of these classifications could only be accounted for through manual reviews. Various potential caveats were considered, but did not lead to the exclusion of any firms from the final sample. These included the standard prerequisites used by other event studies, such as availability of stock performance and firm-level financial data. Additionally, manual reviews of sample firm profiles ensured that they complied with the scope of the present study regarding their main activities (red biotechnology) and company headquarters (Europe).[297]

4.1.2 Event Announcements

The preceding section identified five publications as mutually reinforcing sources of biotechnology firm classifications. Companies identified as part of the industry by the consensus of these publications (a 10% margin of er-

[297] See Table 83 of the appendix for details.

ror accounts for erroneous omissions from individual sources) can safely be considered as the final sample of firms for the empirical analysis. The present section discusses the obtainment of event announcements for these sample firms.

4.1.2.1 Selection of Announcement Source

Event announcements can generally be drawn from two types of sources: General company news services and specialized news databases. Such sources may be either national or international in nature, i.e., containing information on firms from one country or various countries, respectively. Table 2 outlines the four types of news sources used in the event-study (and other empirical) research.[298]

Table 2: Available Sources of Event-Related News Items

	General News Services	Specialized Databases
International	e.g., LexisNexis, Faktiva	e.g., BioScan, Recombinant Capital
National	e.g., DGAP	e.g., NCBI (North Carolina Biotechnology Information)

Source: Own Illustration

Relative to the use of generic (i.e., international, non-industry specific) news providers, both domestic and biotechnology-specific sources may feature distinct advantages: On one hand, the availability of industry-specific alliance databases from providers such as Recombinant Capital and BioScan distinguishes the biotechnology setting from other research contexts. The use of such databases facilitates the research effort and allows constructing large and rich data sets [e.g., almost 2000 announcements studied by (Anand and Khanna 2000a)]. On the other hand, domestic news services possess great credibility due to the legal or quasi-legal

[298] For the present context, national, industry-specific news sources would, however, not be available. As illustrated in Table 78 of the appendix, prior research has extensively relied on the same sources for event-information as for identifying sample firms.

requirements for publicly listed firms to publish materially relevant news.[299]

In the context of the present research, however, general sources of company news may be the only feasible alternative: First, since specialized news services focus on alliance formation (and possibly termination), they fail to provide the required information on their progression and adaptation. Second, a thorough review of data available from Recombinant Capital, the only specialized databases providing information on all 46 final-sample firms, showed that formation announcements often were assigned to a month rather than a specific date, which would prevent the use of daily data in event-study analysis. Furthermore, announcement texts were not available for some alliances listed in Recombinant Capital. Third, domestic news services do not follow the same guidelines across countries and are not available for all countries studied,[300] both of which hinders their use.

Consequently, the present study relies on the LexisNexis database, a widely available general news service, as primary source of event announcements.[301]

4.1.2.2 Sample Selection

A comprehensive LexisNexis search on the 46 sample firms from 01/01/1997 to 12/31/2003 resulted in 2572 news items, of which 690 (or

[299] While the exact provisions vary, all major European countries postulate such mandatory, including §5III of the Swiss Stock Exchange Act (SESTA), the Section 1.3 of the Disclosure Rules set by the UK Listing Authority (UKLA) or §15 of the German Security Trading Law (WpHG).

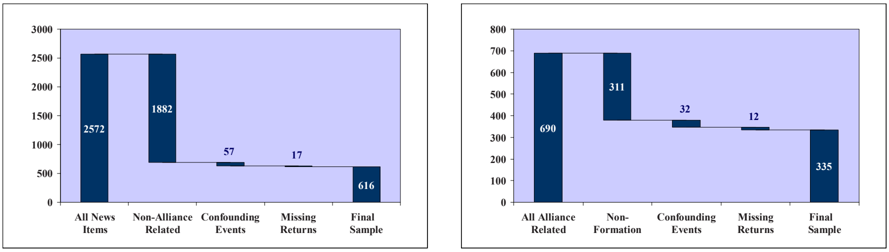
[300] For instance, decode Genetics, a major biotechnology firm headquartered in Iceland, has its primary listing on EASDAQ. Consequently, no European national news reporting would be applicable. Additionally, as corporate disclosure requirements vary across Europe, using mandatory reporting channels might bias the selection of event announcements more strongly than using a source that also includes voluntary disclosure.

[301] Note that LexisNexis and other general news services (e.g., Faktiva) essentially draw on the same data sources, including national mandatory news reporting systems in addition to major international newspapers, business/industry newswires, and company press announcements. Discussions with industry representatives have suggested that the primary difference between these news systems lies in their handling rather than their content.
While earlier event studies had to rely on newspaper reports, which may have a lag of one or more days, newswire items are generally available on the date of the event announcement itself. This is clearly a major factor allowing the use of smaller event windows, which in return are associated with less noise and more precise AR estimates.

26.8%) were related to collaborative activity (379 alliance formation announcements).[302] For the final sample, events were excluded if confounding news announcements appeared on the event day (or within the event period) and if stock return data was unavailable from Datastream for the event day (or event period). This procedure results in a final sample if 616 alliance-related events [cf. Figure 21(a)], of which 328 represent alliance formation announcements [cf. Figure 21(b)].[303]

Figure 21: Derivation of Final Sample Announcements

(a) All Alliance-Related News (b) Alliance Formation Announcements



Data Source: Own Analysis

To better understand the composition of this sample, it was split by year and sample firm:

- Figure 22(a) indicates a sharply rising pattern in alliance-related events (and alliance formation announcements) over the 7 year sampling period. While this reflects an increase in collaborative activity (also see Figure 1d), it may also be affected by the growing number of sample firms due to ongoing IPO activity.[304] The share of alliance formation

302 Table 84 in the appendix details the three-step procedure employed. The total number of alliance-related announcements includes some news extending beyond the scope of the present study, e.g., alliances outside the human health sector, as well as announcements referring to multiple alliances, representing rumors or general firm information, or duplicated alliance-related information already communicated earlier. See subsection 4.2.1.1 for details.

303 Correcting the sample of event announcements for confounding events and missing return data is standard practice in event-study research [e.g., (Thompson 1995)]. Since a single confounding event on any one day invalidates a given observation, the sample size decreases sharply for larger event windows. Table 85 in the appendix provides an overview of the variation in sample size across different event windows.

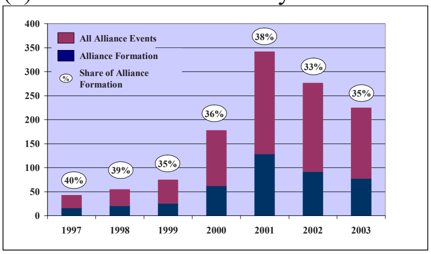
304 The inter-firm activity index later used as an explanatory variable (Hypothesis 10, also see subsection 4.2.2.1) may provide a better indicator of the c.p. in-

announcements (relative to all alliance-related events) remains rather constant over time.

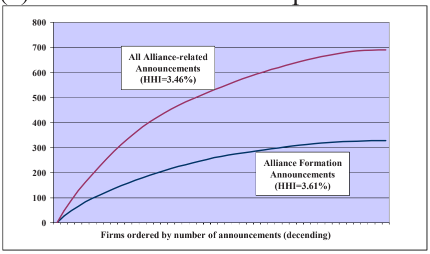
- The cumulative density in Figure 22(b) shows some concentration, i.e., an uneven distribution of alliance-related announcements across sample firms. In fact, the number of events ranges from 0 to 48 (including 27 alliance formation announcements). On an aggregate level, however, concentration does not appear to be excessive, as indicated by a Herfindahl index of 3.46% (3.61% for alliance formation announcements), which is close to the minimum level of concentration for 46 firms (2.17%).[305]

Figure 22: Distribution of Final Sample Announcements

(a) Distribution over Study Period



(b) Distribution across Sample Firms



Data Source: Own Analysis

4.1.2.3 Controls for Consistency

Any approach to identify relevant news announcements may induce a selection bias in the subsequent analyses. That is, if the data source does not provide complete (or at least unbiased) coverage of the events, the derived sample may lead to invalid result. Therefore, the main potential sources of selection bias (in the choice of news source) should be addressed.

As the LexisNexis database does not focus on specific countries or industries, more specialized news sources might be expected to confer news more completely, correctly, or timely. Consequently, the events derived from LexisNexis were compared to both national and industry-specific news sources.

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crease in collaborative activity, since it also includes alliances (and acquisitions) by privately held sample firms, i.e., prior to IPO.

305 In cross-sectional research, event clustering with regard to sample firms may present a problem, if it is correlated with firm characteristics serving as explanatory variables.

National News Reporting Systems: DGAP

In order to analyze potential country-specific biases, this study compared the news announcements for the subsample of German firms derived from LexisNexis® to those published via the German Ad-hoc Publicity Association (Deutsche Gesellschaft für Ad-hoc Publizität). Since firms publicly-listed on the German stock exchange are required to publish all materially relevant news, this database provides a broad benchmark for nationally published news announcements.

Out of the final sample, 9 companies are listed on the German stock exchange (Neuer Markt). Together, both sources yielded 682 news announcements for the time of each firms listing.[306] As indicated by Figure 23(a), the potential bias due to using an international news engine is small relative to its merits. Specifically, only 11% of news announcements (3.7% of collaboration-related ones) were transmitted via the German national reporting system without being similarly included in the LexisNexis® database. Conversely, over 40% of all news items (almost 46.7% of alliance-related ones) were only found in LexisNexis®. About half of all announcements were equally available from both sources.[307]

Although prior German research has used DGAP news announcements [e.g., (Häussler 2006)], this evidence indicates that a broader data source allows capturing event announcements at a more detailed level.[308] Furthermore, this adds to the study's reliability: On one hand, using only events considered 'materially relevant' by the focal firm may result in a 'self-fulfilling prophesy' with regard to the significance of announcement effects. On the other hand, correcting for a greater number of overlapping events during the event window reduces their potentially confounding effects.

While the scope of news announcements included thus favors using the broader LexisNexis® database, the mandated immediate release of relevant news implies that they should generally first be published through the mandatory national reporting system. In order to assess the extent of a potential delay in news transportation, the dates of the 334 news items in-

306 Note that while firms are only required to submit ad-hoc announcements while listed, more general sources also contain news on privately held firms. Consequently, LexisNexis items were only considered if they fell into the time span after focal firms' IPOs.

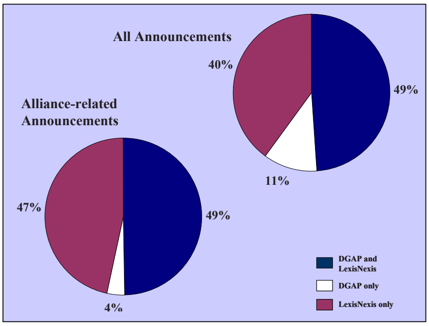
307 Table 86 includes the data on events included in LexisNexis and DGAP, respectively. Table 87 exhibits differences in timing between the two sources.

308 Moreover, this aspect is more pronounced for alliance-related news items, where only formation, termination, and major modifications or milestones may be considered so materially relevant to be published through DGAP.

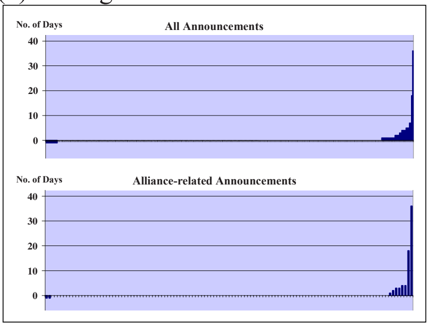
cluded in both DGAP and LexisNexis (thereof 120 alliance-related ones) were compared. Figure 23(b) presents the absolute difference in announcement dates for all common events (top) and for alliance-related events (bottom) ordered from zero to maximum.[309] Overall, around 90% of announcement dates were identical (88% or 296 of 334 overall and 92% or 110 of 120 for alliance-related news). With few exceptions, all delays in news transmission are so small that they would not move the announcement date outside this study's event period.[310]

Figure 23: Comparison of Event Announcements retrieved from LexisNexis® and DGAP

(a) Number of Announcements



(b) Timing of Announcements



Data Source: Own Analysis

Given the relatively homogenous timing of event announcements and the generally small extent of delays, the danger of biased event dates resulting from a general news retrieval system appears small. Together with the greatly superior breadth of event announcements, the analysis of reporting delays thus supports using LexisNexis over national news reporting systems.

309 While LexisNexis news were – as expected – usually provided later than DGAP announcements, 10 of the 40 mismatches (3 of 10 for alliance-related events) had LexisNexis reporting an event earlier than DGAP. In these cases, the absolute difference always was one (1) day, which suggests that the mismatch may result from differences in local time. For instance, LexisNexis may have reported an event after German business hours, whereas DGAP dated it for the following business day.

310 Only two events had a delay of greater than 10 days (18 and 36 days), which would result in them being misdated even for larger event windows. Upon further review, these two outliers appear to be the first announcements following the respective firm's IPO, whereas later time periods did not exhibit similar delays.

Industry-specific databases: ReCap

Industry-specific sources may contain richer and more specific information than general news media. For this reason, alliance records for the sample firms were retrieved from the Recombinant Capital (ReCap) database previously used by other researchers.[311] To allow a meaningful comparison, the information available from ReCap required some revisions to be comparable to the sample of alliance-related news derived via LexisNexis:

- ReCap generally contains only information on the formation of alliances, i.e., it can only be compared to the subsample of announcements related to newly formed alliances, i.e., omitting other alliance-related news items in the final sample.
- ReCap considers acquisitions, dispute settlements, and strategic stock purchases side-by-side with alliance announcements. The description of all ReCap entries were reviewed and only announcements of strategic alliances (and joint ventures) were maintained.[312]
- ReCap includes alliances previously formed by entities acquired by a focal firm in that firm's record. All alliances involving firms other than the focal firm itself (including subsidiaries at the time of announcement) were dropped.

Based on these procedures, the 46 sample firms had 630 relevant entries in the ReCap database. As shown in Figure 24(a), the LexisNexis news-search yielded an additional 83 items not included in ReCap. 44.5% of the total 713 announcements formed part of both ReCap and LexisNexis constituencies. Conversely, 43.9% of all alliance announcements were only available from ReCap.[313]

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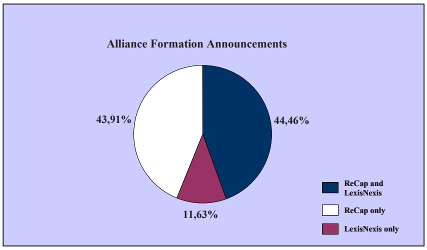
311 The author would like to express his gratitude to Recombinant Capital, Inc., a San Francisco-based consulting and industry information firm, for granting him access to its online database. In addition to serving as a benchmark for the sample selection procedure, the Recombinant Capital database will be used to construct several explanatory variables (see section 4.2.2). All errors and omissions are solely the author's responsibility. Table 78 of the appendix includes some examples of studies having employed alliance-related information from ReCap .

312 As mentioned in subsection 4.2.1.1, some alliance announcements in ReCap may also reflect expansions, adaptation, or even termination of existing collaboration.

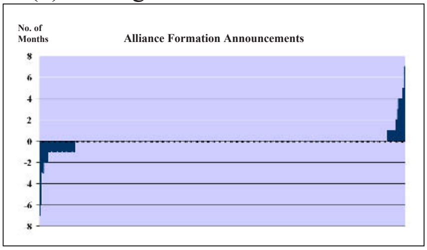
313 See Table 88 for the data on events included in either source; Table 89 for differences in event timing.

Figure 24: Comparison of Event Announcements retrieved from LexisNexis® and ReCap

(a) Number of Announcements



(b) Timing of Announcements



Data Source: Own Analysis

The relatively large share of ReCap announcements not picked up through LexisNexis is worth considering, since it might suggest that main sample derived from LexisNexis is incomplete. It may, however, be at least partially due to the characteristic differences between the two announcement sources. As ReCap does not require the exact announcement date to be known, Alliances not being immediately publicized could be included without occurrence in other news media. A review of non-overlapping entries showed, for instance, that ReCap included alliances announced as part of the annual shareholder meeting, which did not receive separate media coverage and thus were omitted from the LexisNexis-based sample.[314]

Similar to the DGAP comparison above, the timing of LexisNexis and ReCap announcements may diverge. Figure 24(b) presents the difference in announcement timing.[315] For over 85% of concurrent observations (i.e., included in both LexisNexis and ReCap), announcement months matched. Out of the 47 non-zero differences in timing, ReCap dated 23 items one month earlier than the associated LexisNexis news. This may suggest that ReCap considers the actual signing date, whereas LexisNexis relies on the publication in widely available media. Other deviations appeared to be

[314] Overall, there appears to be some tendency of firms to ‘package’ alliance announcements with return announcements, annual meetings, and less favorable news. This may in part explain the relatively high rate of confounding events directly around alliance announcement dates. The main sample includes only collaborative agreements announced individually, i.e., without such confounding event.

[315] Since ReCap provides monthly dates, the differences reported take a value other than zero, if concurrent LexisNexis and ReCap announcements are not dated for the same month. A positive value indicates that ReCap provides a month later than the one for the corresponding LexisNexis announcement. Vice versa for negative values.

random and included a significant share of observations, in which the LexisNexis announcement preceded the month indicated by ReCap.[316]

Overall, the analysis of congruence in constituency and timing of the main sample and the corresponding entries in the DGAP and ReCap databases supports the choice of LexisNexis. First, news reports provide a much richer selection of events than national news reporting systems, such as DGAP. The timing of news announcements is generally synchronous with the mandated corporate reporting. Second, specialized information providers, such as ReCap, may provide access to an even broader universe of events. However, this may come at the expense of reduced validity due to imprecise announcement dates and event classifications. Differences in announcement timing were limited and appear random, i.e., sample selection based on the LexisNexis database should not be biased.

4.2 Data Coding

The preceding subchapter was concerned with validating the source of news announcement employed for the empirical study. The present one presents the actual information coded from these announcements (section 4.2) as well as the complementary data drawn from secondary sources (section 4.2.2).

4.2.1 Information Contained in Event Announcements

All alliance-related announcements identified through LexisNexis were carefully examined and hand-coded to extract their core information. This includes the type of alliance-related event (subsection 4.2.1.1), the collaborative context (subsection 4.2.1.2), and the terms of collaboration (subsection 4.2.1.3).[317] Figure 25 for an overview.

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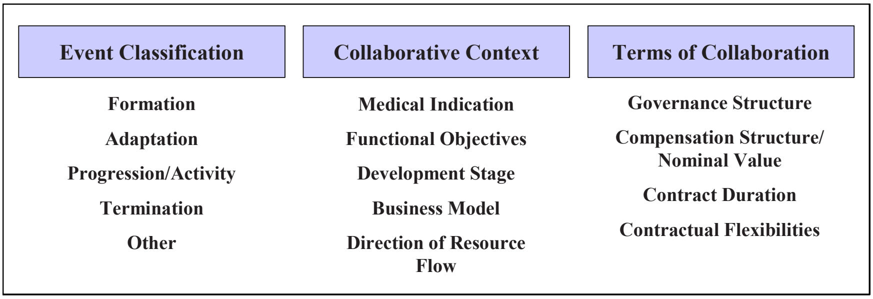
316 The announcement dates for all items not matching the date indicated by ReCap were confirmed through an additional news-search. For some ‘outliers’ it appeared that the ReCap date reflects major milestones of the collaboration. Again this supports the choice of LexisNexis, which best mirrors the information actually available to the market.

317 Consistent with prior research [e.g., (Johnson and Houston 2000)], the intersubjectivenss of the primary data coding was tested using a recoding exercise. The rationale for this approach was to mitigate any risk of systematic coding errors arising from data being hand-coded. Random subsamples were separately recoded by two individuals in order to validate the data and the coding scheme itself. The secondary coders were deliberately chosen to

Figure 25: Levels of Event-Specific Data



Source: Own Illustration

4.2.1.1 Classification of Alliance-Related Events

Studying the evolution of value across the alliance lifecycle (Hypotheses 1-3) requires a segmentation of alliance-related announcements into subgroups of lifecycle events. While alliance formation and termination have commonly been distinguished [e.g., by (Reuer 2000), (Häussler 2005)], the present study extends this line of research by considering a greater variety of alliance-related news (also see subsection 1.3.2.3). In addition to alliance formation and termination[318], announcements regarding alliance adaptation and operations thus represent novel items of study:

- While prior research mostly referred to structural modification of alliances [e.g., (Reuer et al. 2002)[319]], this distinction may be of little valor in the present context due to generally stable alliance structures. As a consequence, adaptation is subdivided into extensions of existing agreements, expansions in the scope of collaboration, and other modifications (which also comprise structural modifications).

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possess complementary backgrounds, holding graduate degrees in pharmacology and business administration, respectively. Based on the results of the recoding exercise, the coding scheme was updated and all primary data coding was reviewed. However, major adjustments were not necessary.

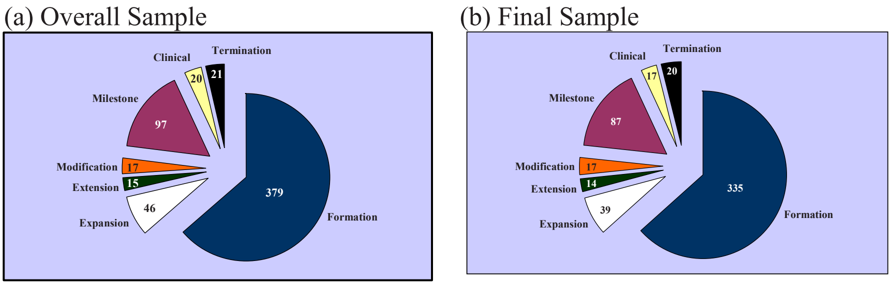
318 (Dussauge and Garette 1998) distinguish five potential end points of JV activities: natural end, extension, premature termination, continuation by one partner, and external takeover. In the present context, termination, however, only refers to the discontinuation of alliances, i.e., excluding internalization or sell-off (cf. Hypothesis 2). This definition of alliance termination is synonymous to the 'liquidation' sub-case utilized in prior event-study research in a JV context [e.g., (Reuer 2000)].

319 (Reuer et al. 2002) study three types of modifications to ongoing joint ventures: Contract alteration, board changes, and change in monitoring mechanisms. Also see subsection 2.4.2.2.

- On an operating level, this study addresses alliance activity and outcome-related news. Alliance outcomes reflect the completion of specific collaboration stages, including the national end point of an alliance. Alliance activity mostly represents collaborative projects advancing into subsequent phases of development.

Based on this classification scheme,[320] the overall sample was divided into event categories. Figure 26 provides an overview of the announcements assigned to each event category before (a) and after (b) correcting for confounding events as well as missing return data. It emphasizes the importance of new alliance formation, which represents over 60% of all relevant news items.

Figure 26: Sample Distribution Across Alliance-Related Event Categories[321]



Data Source: Own Analysis

4.2.1.2 *Coding of Collaborative Context Variables*

The context of a given alliance details the collaborative objectives and activities. In particular, this relates to the targeted industry or market segment

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320 Table 90 of the appendix provides the explicit definitions for the types of alliance-related news considered as part of this study. It also includes a number of complementary news items included to validate the findings regarding the primary event types. These include reruns of previously announced alliances, publicized alliance-related rumors, and news including information on multiple alliances or alliances outside the human healthcare sector. These types of announcements were included in the analysis as benchmarks for the validity of study.

321 These figures only present the 595 events representing the effects considered in Hypotheses 1-3 (529 events after exclusion of confounding events and missing return data). Figure 54 in the appendix also includes non-substantive events, such as rumors, restatements, and announcements referring to multiple alliances or outside the human healthcare sector.

(Control 1), functional alliance objectives (Control 10), as well as the development stage of the collaborative project (Hypothesis 4), the pursued business model (Hypothesis 5), and the direction of intra-alliance resource transfers (Hypothesis 6). As these controls and hypotheses only refer to the value impact of alliance formation, the full set of variables was only coded for such announcements and all descriptive statistics exclude other types of alliance-related announcements.[322]

Industry/Market Segment (Medical Indications)

As a proxy for variation in collaborative value across different market segments (Control 1), the present study distinguishes the medical indication targeted by a given collaboration.

Based on reports published by six major research institutes, banks, and consulting firms, the most important areas of medical indication were identified. The ten indications further considered were singled out by at least four of the six sources and broadly matched classifications used in prior academic work on the biotechnology industry [e.g., (Matraeves 1999), (Tapon et al. 2000), (Breitzman and Thomas 2001)].[323] In addition to the these main indications, announcements were coded as pertaining to more than one indication (various) or as not listing a specific target indication (unspecified).

As indicated in Figure 27(a), no single indication is particularly strongly represented. However, the two most common indications reportedly also are the ones most targeted by biotechnological development projects: Cancer (42%) and infectious diseases (11%) [cf. (PhRMA 2002)]. Since both make up about 12% of the present sample's events, cancer may be underrepresented. At the same time, over 40% of all alliance formation announcements did not refer to a specific target indication. Due to both of these limitations, the data on targeted medical indications should be considered cautiously.

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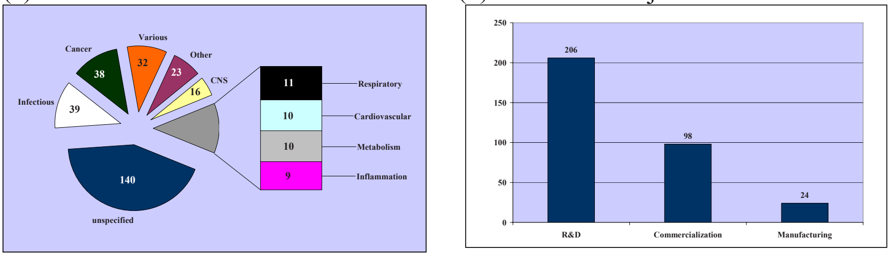
[322] Note that all sample descriptives are provided for the 328 alliance formation announcements without confounding events in the 2-day event window (-1/0). 335 observations were available for day 0 alone.

[323] The only other indication included in over half the publications, diabetes, represents a specific type of metabolic disease. Therefore, only the main category was included in the final classification scheme. Table 91 and Table 92 in the appendix present the analysis of research reports as well as the comparison to prior research, respectively.

Figure 27: Sample Distribution Across Medical Indications and Functional Objectives

(a) Medical Indications

(b) Functional Objectives



Data Source: Own Analysis

Functional Area of Collaboration

The functional focus of collaboration may be controlled for by classifying alliances according to their primary objectives. In particular, prior evidence on collaborative value suggested that technology-related may be most value-enhancing (Control 10).

Most authors have distinguished R&D alliances from marketing and/or manufacturing alliances [e.g., (Garcia-Canal and Sánchez-Lorda undated), (Merchant and Schendel 2000)]. Similarly, technology-related and non-technology alliances may differ in their value impact [e.g., (Chan et al. 1997), (Campart and Pfister 2003)]. The two definitions are, however, not fully congruent, since technology alliances may include licensing (i.e., technology transfer) as well as R&D [e.g., (Brooke and Oliver 2004), (Socher 2004)]. Conversely, licenses may also be granted for commercialization purposes, i.e., distinctly unrelated to R&D. Therefore, the present study employs a relatively simple coding scheme expanding the definition of R&D alliances to include technology transfers, but not licensing per se:

- Research & Development (R&D), also including Technology Transfer
- Manufacturing
- Commercialization, including Supply and Marketing Agreements

While this distinction of functional areas is straight-forward,[324] alliances may relate to more than one functional area. For instance, out-licensing or development agreements often include provisions regarding subsequent activities, such as manufacturing and marketing the resulting drugs. Similarly, commercialization agreements may entail joint development of complementary or next-generation products. Since separate coding of all these

[324] Table 93 of the appendix details the definition of these functional alliance objectives.

functions would reduce the variation in observations, the coded variable only refers to the primary function of collaboration.[325] A separate variable was used to account for alliances explicitly extending to more than one functional objective.

Figure 27(b) above summarizes the sample composition with regard to the primary functional focus of collaboration. It highlights that technology-related (R&D) collaboration is the by far most common alliance objective (accounting for almost 63% of all observations).

Development Stages

Collaborative projects in different stages may have distinct effects on firm development and performance. In particular, advanced-stage (or exploitation) collaboration may be particularly valuable to European biotechnology firms (Hypothesis 4).

In the biotechnological industry-context, most researchers have built on the drug development model (also see subsection 1.3.2.1, p. 12). Consequently, the main difference between the coding schemes employed by Hand (2001), (Lerner et al. 2003), (Lerner and Merges 1997, 1998), and (Robinson and Stuart 2002) lies in their levels of detail.[326] In distinguishing exploration and exploitation alliances, (Rothaermel and Deeds 2004) code all alliances addressing activities preceding clinical tests as exploration and alliances focusing on later stage projects as exploitation. However, this approach does not account for platform technologies and diagnostics being distinct business models not underlying the generic drug discovery model.

The present study employs a comparably detailed coding scheme, including 9 stages of drug discovery (and drug-discovery services) as well as two categories reflecting the development and commercialization of technologies and diagnostics. Exploitation alliances comprise clinical or post-

[325] Truly distinct functional interactions, however, were coded as separate activities. This include cases, where one firm grants another marketing rights to its products, but maintains exclusive manufacturing rights and becomes a supplier to its marketing partner. As such alliances are broader in scope, i.e., included a manufacturing in addition to a marketing focus, such secondary fuctions were coded as part of an alliance scope variable.

[326] While some studies distinguish clinical phases individually, others aggregate them into one category. Similarly, target- and lead-related stages may be distinguished from pre-clinical animal models or combined into one ‘preclinical’ stage. Table 94 in the appendix provides an overview of the most relevant studies and reports. Table 95 shows the definitions of development stages for the drug discovery (including service provision) and platform technology business models.

clinical drug projects as well as technology and diagnostics commercialization. Similar to the case of medical indications, two additional categories were created to include alliance activities not associated with a particular development stage (unspecified) and those explicitly affecting various stages (various). Table 28(a) and (b) give an overview of the frequencies.

Collaborative Business Models

The business model pursued by a collaborative venture may substantially affect its value-creation potential (Hypothesis 5). While prior research has often studied the biotechnology industry at a relatively abstract level,[327] DBFs' business models may be subject to substantial heterogeneity. In this context, (Fisken and Rutherford 2002) and (Champenois et al. 2004) distinguish business models by the focal firms' contributions to the overall product development process. Analyst research reports utilize similar classification schemes. Incorporating elements of these classifications, the present research distinguished five main business models that may be pursued by means of collaboration:[328]

- Drug Discovery
- Platform Technology
- Service Provision
- Diagnostics and other Products
- Hybrid

Table 28(c) presents the frequency distribution of collaborative business models in the subsample of alliance formation announcements. Drug discovery is the most common collaborative business model (36.3%), followed by platform technologies (29.0%) and service provision (26.8%). Diagnostics and hybrid alliances are of minor import.[329]

327 For instance, (Lerner and Merges 1998) and (Lerner et al. 2003) as well as (Folta and Miller 2002), (Folta and Ferrier 2000), and (Folta 1998) distinguish therapeutic, diagnostic, agricultural, and specialty chemical products. The main intent of these studies was to sufficiently correct for differences in regulatory scrutiny and market potential, while focusing on other explanatory variables. In contrast the present work attempts to evaluate the valuation effects originating from different business models.

328 See Table 96 in the appendix for more precise definitions of the different business models.

329 Note that, contrary to the general usage, the present scheme applies the business model notion not on the corporate but on the transaction level. That is, the collaborative business model reflects the object of the collaboration rather than the main focus of firm activities. Hybrid alliance thus incorporate several business models (e.g., drug discovery and diagnostics), whereas firms

Direction of Resource Transfers

As some researchers [e.g., (Park and Kim 1997), (Campart and Pfister 2003)] have suggested, 'buyer' and 'seller' sides in strategic alliances earn different ARs. In particular, DBFs may profit more from capitalizing on their technological resources as 'sellers' vis-à-vis Big Pharma 'buyers' (Hypothesis 6). Similar to prior research [e.g., (Johnson and Houston 2000)], the direction of resource transfers was classified as a categorical variable, comprising three main directions:[330]

- Inbound transactions
- Outbound transactions
- Joint/Cross transactions

The 'joint/cross' category expands the standard 'buyer'/'supplier' distinction to account for collaborative projects similarly drawing on both partners' resources. Table 28(d) provides an overview of the present sample.

Overall, the direction of resource transfers combines with the functional focus, development stage, and business model variables to comprehensively characterize biotechnology alliances. Their incidence and effects may be interdependent.[331] Therefore, interaction terms were constructed to account for their simultaneity.

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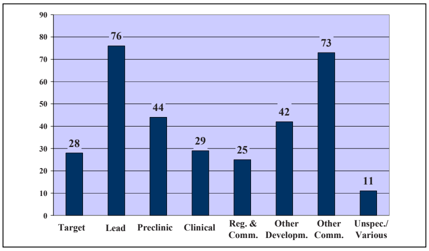
may pursue hybrid business models by separately using several different collaborative business models;

330 Resource transfer may be interpreted rather broadly in this context. While technology transfer, marketing and supply agreements in fact physically transfer the drug, technology or product, the assignment of residual property rights (e.g., research output) determines the direction in service and R&D alliances. Table 97 in the appendix provides more detailed definitions.

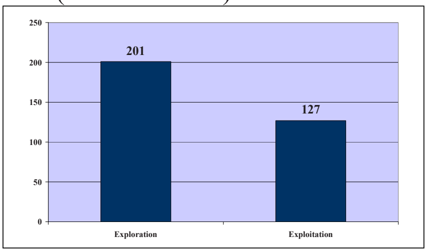
331 For instance, both in- and outbound transactions tend to exploit partner and focal firm resources, respectively. Joint transactions may be either explorative or exploitative in nature, depending on whether they create or merely transfer resources. This perspective complements the stage-based distinction of exploration and exploitation alliances, since technological knowledge may already be transferred (i.e., exploited) during earlier stages.

Figure 28: Sample Distribution Across Development Stages, Business Models, and Directions of Resource Transfers

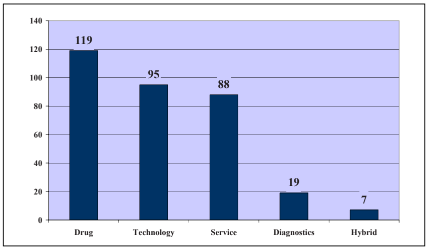
(a) Development Stages (Full Scale)



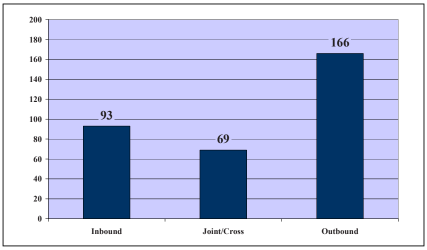
(b) Development Stages (Reduced Scale)



(c) Business Models



(d) Directions of Resource Transfers



Data Source: Own Analysis

4.2.1.3 Coding of Structural Alliance Characteristics

Structural alliance reflect the economic implications of collaborative ventures. In particular, the collaborative governance structure (Control 11) as well as the existence and extent of intra-alliance payments (Control 12) substantially affect the value implications of strategic alliances. Furthermore, the structure of these inter-partner payments (Hypothesis 7), time-limited alliance duration (Hypothesis 8), and contractual flexibilities (Hypothesis 9) may reduce informational asymmetries and provide incentives for cooperative behavior.

Collaborative Governance Structure

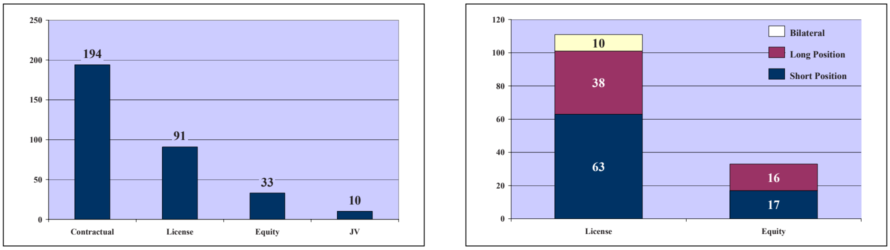
Prior research has demonstrated a relevant value-impact of JV [e.g., (Koh and Venkatraman 1991), (Piachaud and Muresan 2004)] and equity-supported [e.g., (Kale et al. 2002), (Kim and Park 2002)] collaboration (Control 11). Following the precedent of (Nicholls-Nixon and Woo 2003) and (Tapon et al. 2001), among others, the present study distinguishes four main types of collaborative governance:[332]

- Contractual collaboration
- Licensing, i.e., involving the explicit transfer of property rights
- Joint Ventures, i.e., involving the formation of a joint subsidiary
- Equity-based transactions, i.e., at least one partner taking an equity stake in the other

These four subtypes are listed in order of increasingly stringent control rights: Licensing provides more formal control over the object of collaboration than contractual alliances, although the choice of licensing may be related to the nature of the alliance (e.g., technologies or drug candidates as opposed to services). While JVs allow direct control through (partial) ownership of the subsidiary, equity participation extends the hierarchical control to the partner firm itself.[333] Figure 29 summarizes the sample use of governance mechanisms.

Figure 29: Sample Distribution Across Governance Mechanisms

(a) Use of Governance Mechanisms (b) Direction of Licenses and Equity Investments



Data Source: Own Analysis

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332 Both (Nicholls-Nixon and Woo 2003) and (Tapon et al. 2001) use an even broader classification extending to corporate acquisitions (and asset sales), which do not fall into the definition of collaborative ventures pursued here. Other authors rely on less expansive classifications distinguishing only licensing and contractual alliances [e.g., (Robinson and Stuart 2002)] or joint ventures and contractual collaboration.

333 While JV co-ownership and (minority) equity stakes may be functionally similar with regard to the control of the collaboration itself, the latter entails a financing effect for the recepient of the equity investment. It can thus also be interpreted as a component of intra-alliance compensation.

Intra-Alliance Payments & Compensation Structure

In terms of inter-partner payments, it may be better to take than to give (Control 12). That is, incoming financial [(Campart and Pfister 2003)] and in particular equity inflows [(Park and Martin 2001)] increase collaborative value, whereas equity investments in partner firms [e.g., (Wang and Wu 2004)] may even decrease it. Consequently, the nominal value of financial payments between alliance parties was recorded:

- Payments receivable from partner in m€[334]
- Payments payable to partner in m€

More specifically, the structure of inter-partner payments may affect collaborative value creation. Specifically, sponsored firms retaining a stake in the upside potential of collaborative project have incentives to behave cooperatively (Hypothesis 7). In this context, most prior literature distinguishes upfront, milestone, and royalty payments [e.g., (Finch 2001), (Christensen et al. 2002), (Robinson and Stuart 2002), and (Higgins 2006)].

In the real world, transaction terms may be even more diverse, which requires the aggregation of different payments into these categories:

- Guaranteed payments, including upfront payments, research funding and annual license fees[335]
- Milestone Payments, referring to the achievement of operational milestones, i.e., are subject to technological uncertainty
- Royalty rights, including commercial milestone payments, revenue sharing, and specific commercialization rights (e.g., for certain territories or applications), which underlie both technological and market risks

In total, the financial implications of a given transaction are reflected in the existence of inter-firm payments, their nominal value, and their struc-

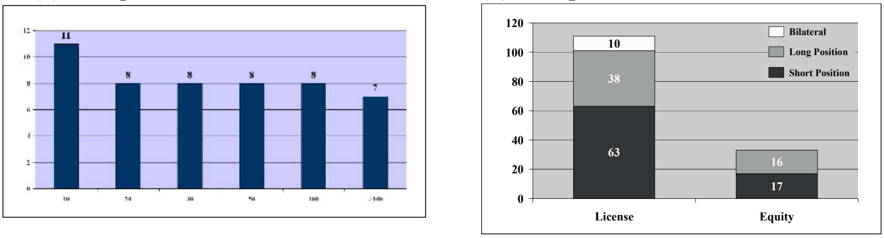
[334] Following the standard practice employed by the announcing firms, the value refers to the sum of upfront, guaranteed, and milestone payments, i.e., excluding royalties and similar payments. For payments not provided in Euro, the value was converted using the appropriate exchange rate on the day of the transaction.

[335] While upfront payments are generally payable upon signing of the alliance contract, other guaranteed payments may be spread out over the duration of collaboration. The most important distinguishing feature of this category thus is the non-conditioning on collaborative achievements, short of alliance termination or partner default. Table 98 of the appendix details these definitions. Table 99 extends to structural alliance characteristics more broadly.

ture.[336] Figure 30 provides an overview of the frequency distributions, which shows a broad spread of compensation value (a) and structural compensation characteristics (b). In particular, this provides no indication of (upward-)biased reporting of compensation values. With regard to compensation structure, incoming payments appear more frequent, which is in line with the large share of outbound alliances.

Figure 30: Sample Distribution Across Compensation Value and Structure Categories

(a) Compensation Value (b) Compensation Structure



Data Source: Own Analysis

Contractual Provisions

Alliance duration may be limited to reduce collaborative uncertainty and provide incentives for cooperative behavior. In particular, the choice of limited-term collaboration may reflect information asymmetries and thus reduce, whereas the actual duration of an alliance may be value-enhancing (Hypothesis 8). Consequently, reported information on contract duration was coded as two separate variables:

- Time limitedness, i.e., collaboration is not open-ended
- Contractually fixed alliance duration (in month)

In addition to time-limitedness and formal governance structures, the flexibilities inherent in collaborative ventures may also serve as detriments to partner opportunism (Hypothesis 9). While (Folta and Miller 2002) only consider options to acquire partner firms, alliance contracts may be contain a variety of explicit flexibilities, including options to extend, expand (e.g., to add further drug targets), or modify (e.g., to gain commercial licenses upon market entry) the collaboration. This also includes stock purchase op-

336 Note that the both compensation value and structure are coded conditional on the information being explicitly included in the announcement text. That is, analyses thus test a joint hypothesis that (a) the compensation structure and value and (b) the fact that firms provide such information significantly effect collaborative value creation.

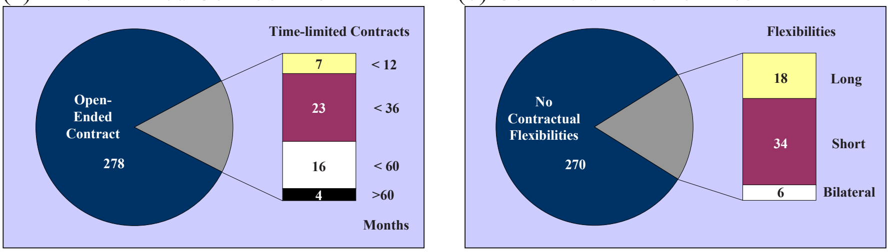
tions and the flexibility associated with convertible debt or preferred equity.[337] Consequently, the present study accounts for any kind of contractual flexibility mentioned in the announcement texts:

- Explicit option rights allocated to the focal firm at the time of formation (long position)
- Explicit option rights allocated to partner firms at the time of formation (short position)
- Explicit option rights allocated to both/all collaborating firms at the time of formation (bilateral)

Figure 31 presents the frequencies of time-limited collaboration (a) and contractual flexibilities (b). Both contractual provisions are relatively infrequent, being reported for 15.2% and 17.7% of alliance formation announcements, respectively. If restricted, collaborative duration tends to be fixed for medium time-horizons; such 37 of 50 alliance contracts were set for 24, 36, or 60. Explicit flexibilities are more often granted to partner firms (12.2%) than to focal firms (7.3%).

Figure 31: Sample Distribution Across Compensation Value and Structure Categories

(a) Time-Limited Collaboration (b) Contractual Flexibilities



Data Source: Own Analysis

4.2.2 Secondary Data

In addition to the information contained in the alliance-related news items themselves, the present study builds on several secondary data sources. In addition to the stock and index return data used in the event-study analysis (see subchapters 4.3 and 4.4), these sources also provide the explanatory

337 Note that collaborations involving convertible preferred equity or debt also possess characteristics of both equity-based transactions, i.e., the threat of gaining explicit control rights. Consequently, they are coded as both equity-based and explicit flexibilities.

variables required to account for environmental and firm-level controls and hypotheses in cross-sectional analyses.

4.2.2.1 Environmental Data

On an inter-firm level, collaborative value creation may depend on the relatedness between collaborating firms (Control 2) and the international scope of collaboration (Control 3). Moreover, general economic conditions (Control 4), competitive pressures to adapt (Hypothesis 10), and environmental uncertainty (Hypothesis 11) may affect the collaborative value potential.

Partner Relatedness

While other studies have used standard industry classifications [e.g., (Chan et al. 1997)] to assess the relatedness of alliance partners, the prevalence of alliances within the bio-pharmaceutical industry does not support this approach. Specifically, the position of firms and institutions along drug development process determines the relatedness of their knowledge bases (see subsection 1.3.2.3). Based on the ReCap classification of collaboration partners, four categories of firms were distinguished:[338]

- Pharmaceutical firms tend to be vertically (downstream) related to DBFs, since they tend to purchase platform technologies and service or acquire into drug development projects.
- Universities, research institutes, and hospital organizations are vertically (upstream) related to DBFs. These institutions mostly perform basic research and may supply the biotechnology industry with drug targets, lead structures, or services.
- DBFs are horizontally related to each other, since they build on similar technologies and resources and operate in similar product markets (e.g., the market for service provision to Big Pharma firms).
- Other organizations are assumed to be unrelated to DBFs. Among others, these may include governments purchasing vaccines in public health

[338] The ReCap database distinguishes pharmaceutical, biotechnology, and university-related organizations. Further review produced some (<10) irregularities, in particular publicly held pharmaceutical and/or biotechnology firms coded as university-related. These codings were changed based on internet-research into the organizations' background. Similarly, universities, hospitals, and research institutes not included in ReCap were coded as such. All other organizations not categorized in ReCap were coded as "other".

interests or conglomerate firms applying some biotechnological technologies in their food divisions.[339]

The distribution of sample events across these four categories [Figure 32(a)] shows that more than half of all alliances are horizontal in nature, i.e., involve another DBF (51.22%). Only one quarter are downstream alliances with Big Pharma firms (24.7%). Unrelated (14.9%) and upstream (9.1.%) collaboration is of limited import.

International Scope of Collaboration

As biotechnology collaboration only sparingly focuses on geographic market entry,[340] the distinction of partner firm origin and host country relatedness is moot in this context. The present study therefore recorded the partner firms' geographic origin, distinguishing the three main pharmaceutical markets worldwide:[341]

- North America (including the U.S. and Canada)
- Europe
- Japan
- Other Countries

The frequency table shown in Figure 32 (b) indicates that transatlantic and intra-European collaboration is by far most common, combining for about 90% of all sample alliances.

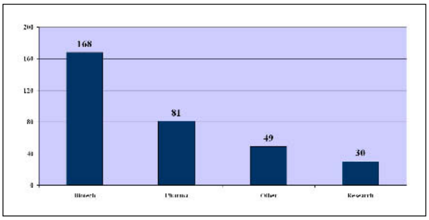
339 Firms not included in the ReCap database included two types requiring manual revision: (a) firms having been acquired or merged and were no longer separately listed in ReCap were coded as belonging to the same category as the acquiring or merged entity. (b) Some very small biotechnology firms or research institutes were not included in the database. Consequently, all excluded entities were reviewed and recoded as appropriate (based on company accounts, webpages etc.).

340 Specifically, only 54 of 328 transactions (16.5%) involved a limited geographical scope. For all other alliances, no host country could be determined. Additionally, the specified geographic scope ranged from single country alliances to broader agreements on the separation of future commercialization rights.

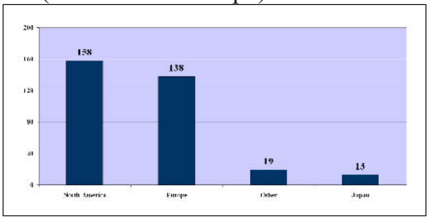
341 (Sleuwaegen et al. 2003) employ a similar classification scheme in a more general context. The distinction of European, North American, and Japanese partners may thus catch industry-specific as well as general economic and cultural aspects. Partner firm origin was coded based on the information in the announcement texts. All codings were validated using publicly available sources, such as company websites.

Figure 32: Sample Distribution Across Relatedness and International Scope Categories

(a) Partner Type (Relatedness)



(b) Partner Origin (International Scope)



Data Source: Own Analysis

Environmental Conditions: Munificence and Uncertainty

Environmental conditions provide the background for collaborative activity, both in terms of munificence providing attractive alternatives (Control 4) and uncertainty potentially rendering flexible alliance schemes more attractive (Hypothesis 11):

- While (Park and Mezias 2005) employ a dichotomous measure of environmental munificence, the present study period purposefully employs various times of stable (e.g., prior to 1999), highly munificent (e.g. year 2000), and steeply declining (e.g., year 2001 to mid-2002) market environments. Therefore, a continuous measure of environmental munificence was used, the cumulative return on the basket of sample firms over a 200-day windows ending 11 days prior to the event announcement. This measure effectively represents an (equally weighted) intra-sample return.[342] Figure 33(a) exhibits the distinct pattern of biotechnology market development over the study period (1997-2003) relative to the more stable general economic environment (reflected in the Stoxx 600 development).
- While prior studies have addressed the technological basis of an industry [e.g. (Hanvanich et al. 2005)], or industry-level competition [e.g., (Merchant and Schendel 2000)] as potential determinants of environ-

342 For validation purposes, this self-constructed index was compared to U.S. biotech (NASDAQ Biotech), generic European biotech (STOXX Biotechnology Total Market), and general European indices (Stoxx 600). The measures for the biotechnology-specific were highly congruent, whereas the broader Stoxx 600 deviated substantially, which reinforces the choice of an industry-specific measure.
Also note that the 200-day time-window coincides with the estimation window used in the event-study proceduce (see subsection 4.3.2.2).

mental uncertainty, none has employed an aggregate measure. Given the (regional as well industry-related) homogeneity of the present sample, however, it is reasonable to expect that environmental uncertainty similarly affects all sample firms. Consequently, environmental uncertainty was proxied by stock-market volatility; specifically, the standard deviation of intra-sample index returns over the above 200-day window.[343] It exhibits a roughly similar pattern as the returns [also see Figure 33(a)]. However, the decline in volatility following the burst of the market bubble is slower, i.e., as market values fell, volatility remained comparably high.

Institutional Pressure

As market activity is expected to reflect the institutional pressure to collaborate or fall behind industry competitors (Hypothesis 11), a reasonable measure should take into account the relevant market and all relevant transactions. Using the transaction data provided by ReCap, the total number transactions by all sample firms was counted over the 12-month period preceding the event month. As ReCap includes alliances and M&A transactions, this approach accounts for a broader scope of market activity than using a purely intra-sample measure.[344]

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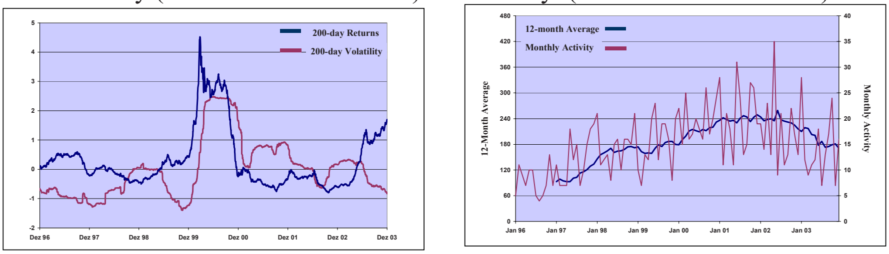
[343] As the derived volatility measure was limited to non-negative values, an alternative normalized (i.e., centered on its mean) measure was calculated to facilitate its interpretation. Both measures were also standardized (i.e., divided by their standard deviation) to correct for non-normality. None of these modifications lead to changes in the observed effects of either measure (see subsection 5.3.2.3)

[344] While alliance activity has not been considered in prior research, (Moeller et al. 2004) apply a market-activity index [developed by (Schlingemann et al. 2002)] to the value impact of M&A transactions. Specifically, their liquidity measure is defined as the combined value of M&A deals relative to the book value of assets, with both being calculated by industry (2-digit SIC code). As the value of financial payments is unavailable for many collaborative ventures, collaborative activity can only be measured as a count variable.
The choice of a monthly updated alliance activity measure is to ReCap only providing monthly dates for all transactions. A potential bias due to using the number of alliances formed up to the prior month rather than the event date (e.g., underestimation of the transaction count during high-activity eras) should be small.
Again, the count variable was normalized and standardized to improve its statistical properties, which did not alter the substantive findings presented in subsection 5.3.2.2).

Figure 33: Development of Stock-Market and Market-Activity Measures over Sample Period (1997-2003)

(a) Environmental Munificence and Volatility (Standardized Measures)

(b) Monthly and 12-month Market Activity (number of transactions)



Data Source: Own Analysis

Figure 33(b) indicates a steadily though not steeply increasing activity level of interorganizational activity, which climaxes in mid-2002.[345]

4.2.2.2 Company-Level Data

Various firm-level factors may provide the basis for collaborative benefits [e.g., partner-firm resources (Control 6)] and successful cooperation [e.g., transaction experience (Control 7), prior relations (Control 8)], but also potential agency effects [e.g., firm performance (Control 9)]. Furthermore, firm development may fundamentally affect the value impact of collaborative ventures (Control 5/Hypothesis 12). The present subsection addresses measures of firm development, resource endowments, and indicators of information asymmetries. Table 3 presents the summary statistics of partner and focal firm resource variables.[346]

Firm Development

As the most general firm-level determinant, firm size or more generally firm development may affect both the overall benefits firms derive from

345 Potential explanations for the decrease in interorganizational activity from late 2002 to the end of the study period may be diverse. Most strikingly, the number of sample firms decreases over this period due to mergers and takeovers as well as the absence of IPO activity.

346 Partner firm resources were separately coded to account for partner being subsidiaries of larger organizations. As Figure 58 in the appendix shows, 15 alliances involved non-independent entities. With regard to partner status, these were treated as public firms, since they have access to similar resources and restrictions through their publicly-listed parent firms. Partner (pstatus) firm status itself was also tested as a control for partner firms' commercial capital.

collaboration (Control 5) as well as moderate other influences on collaborative value creation (Hypothesis 12):

- As prior research liberally alternates the use of workforce [e.g., (Park and Martin 2001)], sales [e.g., (Kale et al. 2002)], total assets [e.g., (Anand and Khanna 2000)], and market value [e.g., (Park and Mezias 2005)] as proxies for firm size, the present study compiled all these measures. While such numbers are included in the company profile available from Datastream (at least on an annual basis), the available data was scrutinized to ensure their validity.[347] All financial figures were converted into Euro (€) or (previously) ECU.
- In order to derive an alternative measure of firm development and organizational legitimacy, firm age was coded as the time since the companies IPO (in days). The data required to construct this measures was obtained from a variety of sources, including stock exchange listings, annual reports, company websites, and press articles.[348]

347 With regard to workforce (i.e., number of employees) sales and total assets, the respective figures were randomly compared to the focal firms' annual reports without exhibiting substantial deviations. As part of this exercise, any missing values in the Datastream data were imputed using the figures indicated in the annual reports, given the availability of reports.
The market value of equity was recalculated based on the daily stock prices and numbers of shares outstanding available from datastream. The comparison of the calculated market value of equity and the figures provided by Datastream exposed two deviations: First, the year-end figures were subject to rounding errors in quite a number of cases. Second, the unit of measurement differed by factor 10 between UK and non-UK companies.

348 The measure was transposed to its natural logarithm to account for clustering in IPO activity. Table 3 presents the raw measure to facilitate interpretation.
An alternative approach, measuring firm age as the time since the companies' foundation, was hindered by a variety of pitfalls: First, the companies' date of foundation often could not be pinpointed to a specific date (or even month) leaving only a cruder, annual measure. Second, the foundation of a legal entity differed from the age of an organization, since some European DBFs were founded as spin-offs from research institutes or other (parent) firms. One, Active Biotech of Sweden was transformed into a DBF after being established as investment company almost 15 years earlier (1983-1997). Third, some transitions may have been gradual in nature. For instance, the time of transformation of Berna Biotech (from a public research institution founded in 1898) and Serono (having been a private pharmaceutical firm, since its inception in 1903) could not be identified, even in telephone interviews of company representatives.

Table 3: Summary Statistics of Firm-Resource Data

Variable	Unit	N	Mean	Median	Std. Dev.	Min	Max
(Focal) Firm Size							
focalstaff	No.	317	510.66	183	859	12	4,597
focalsales	k €	303	90,867	12,407	223,370	16	1,447k
focal-assets	k €	324	300,017	149,937	499,206	6,288	3,275k
focalmve	k €	310	860,210	274,020	1,743k	12,956	11,600k
(Focal) Firm Age							
agep	Days	328	1270.94	1006	1,040.76	133	5674
Partner Firm Patents							
pp	No.	328	1,724.21	36.50	6,288.17	–	77,850
pppp	No.	328	2,132.75	46.00	7,167.89	–	77,850
Partner Firm Alliances							
ptrans	No.	328	62.71	11.00	110.97	–	595
ppptrans	No.	328	71.10	13.00	124.14	–	619
Focal Firm Patents							
focalp5	No.	328	61.17	56.00	68.62	–	304
focalp3	No.	328	79.55	38.00	66.66	3.00	269
focalpr	No.	328	0.10	0.11	0.95	(2.86)	2
Alliance Experience							
experience	No.	328	27.28	20.00	29.08	-	141

Source: Own Analysis

Firm Resources

While partner resources are considered as sources of collaborative benefits (Control 6), focal firm resources may affect its attractiveness as an alliance partner and thus indirectly influence collaborative value (see Hypothesis 13).[349] Data on both focal and partner firms' resources were taken from publicly available data sources:

- In line with prior research, technological resources are measured using a patent-count variable [e.g., (Owen-Smith and Powell 2004)]. The number of patents granted to a given firm was retrieved from the European Patent Office's esp@cenet® worldwide database for the five calendar years preceding alliance formation.[350] Various researchers [e.g. (Rothaermel and Deeds 2004), (Ahuja 2000b)] used a same-length window to smooth annual variation in patenting and to account for the declining value of older patents.

  In addition to this standard approach, however, the patents granted during year of alliance formation as well as the two subsequent years were also considered. This should account for the potential relevance of technological innovations still under review by international patent offices. Given the pressure to speed the drug-development process, firms may enter into alliances based on such resources rather than wait for formal patent granting.[351]

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349 Focal firms‘ technological may also reflect its absorptive capacitay, i.e., its ability to assimilate partner knowledge (see proposition 2.5). While this analysis exceeds the present study‘s research objectives, it was briefly assessed. The results presented in Table 172 of the appendix, however, revealed no significant direct effect on ARs.

350 esp@cenet® (http://ep.espacenet.com) provides access to several patent databases, most of which are limited to patents granted over the preceding 24-month period. The worldwide database, however, contains patents dating back far beyond the five years generally used. Additionally, it provides access to patents granted in Europe, the U.S. as well as by the World Intellectual Property Organization (WIPO). Consequently, the obtained patent count accounts for the international reach of innovation, contrary to the usual domestic approach.

351 Based on the two time horizons, an additional measures may be calculated to reflect the novelty of a firms' technology. Specifically, the sample firms were ranked based on the number of patents issued over the two time-windows. The 5-year rank was then deducted from the 3-year rank, indicating the number of positions a firm has climbed (or fallen) from the historic to the current ranking.

- Also building on prior research [e.g., (Shan et al. 1994), (Gulati 1995a), (Anand and Khanna 2000), (Park et al. 2004)], partner firms' social capital and focal firm alliance experience (Control 7) were measured using an alliance-count variable. Specifically, the number of prior alliances formed (at the time of alliance formation) was derived from the ReCap database.[352] M&A transaction were excluded form the count. Conversely, alliances initially formed by firms later acquired (as well as by subsidiaries) were included, reflecting the assumption that social capital (and alliance experience) may be transferred as part of post-merger integration.
- Partner firm commercial capital was measured using dichotomous variable indicating whether a partnering entity was publicly listed [see (Chung et al. 1993) for a similar approach]. While more elaborate measures exist,[353] stock-market data (e.g., market value of equity), standard accounting information (e.g., total assets), or even operational measures (e.g., number of employees) would not have been available for many research institutions or privately-held partners. The partner-firm status was coded from the announcement texts and publicly available sources, such as company reports, websites, and stock-exchange listings.

Determinants of Information Asymmetries

In addition to firm development and both collaborators' resource bases, firm-level variables may also reflect different types of information asymmetries:

- Focal firm performance and slack resources may be at the root of agency problems between focal firms and outsiders (Control 9). Consequently, focal firm profitability (EBIT), (Net) cash-flows, and internal growth opportunities (Tobin's q) were measured based on Datastream

[352] For partner firms not themselves included in the ReCap database, the number of prior alliances derived maz be downward biased. In particular, only alliances with DBFs, pharmaceutical firms, or other entities included in ReCap are part of the resulting alliance count. As these relations, however, compose the core of relevant social capital, the potential bias is small and may in fact increase the validity of the measure. Otherwise, prior alliances outside and within the biopharmaceutical industry would be considered equivalent.

[353] The measures of firm development described above have all been used as indicators of commercial capital (also see subsection 2.2.2.2). Therefore, no separate measures of focal firm's commercial capital were derived.

data for the year preceding the alliance announcement.[354] Summary statistics are included in Table 4.

Table 4: Summary Statistics of Firm-Performance Data

Variable	Unit	N	Mean	Median	Std. Dev.	Min	Max
Firm Performance							
focalebit	m €	311	(18.6)	(12.9)	111.2	(680.1)	441.8
focalncf	m €	323	13.6	(1.1)	101.8	(480.7)	1,017.9
focalq	q	310	3.09	1.84	3.78	0.10	31.54

Source: Own Analysis

- Finally, relationship-specific social capital may mitigate information asymmetries between alliance partners (Control 8). The measure constructed as a binary variable reflecting the existence of prior collaborative relations between focal and partner firms. The information on prior alliances was derived from the alliance announcement texts, prior intra-sample alliances (i.e., earlier alliance-related announcements), and a thorough search of the ReCap database. As these three sources may reflect different types of interactions[355], evidence from any one source was considered sufficient to constitute prior inter-firm relations.

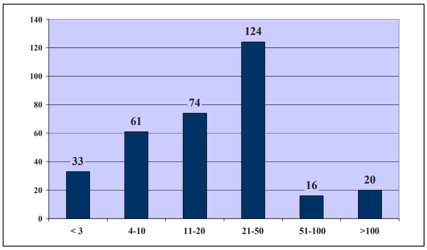
  Given the relatively high frequency of collaboration, the share of repeated interactions is surprisingly low [see Figure 34(a) and (b)]. Specifically, only about 16.5% of all alliances were formed between partners with prior ties.

[354] As Tobin's q is defined as the ratio of the market value of the firm to the (market) value of its individual assets, it is generally not observable. Instead, the present study calculated a pseudo-q based on the approximation proposed by (Chung and Pruitt 1994). It uses the book value of assets (net of the book value of debt) a proxy for the value of a firm's assets.

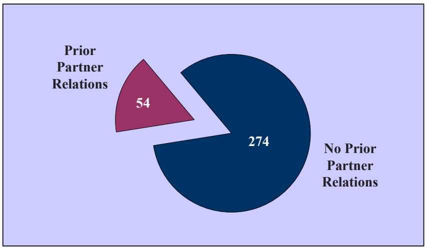
[355] Specifically, prior relations mentioned in alliance announcements often include informal contacts, such as buyer-supplier relations or pre-contractual evaluation phases. On the other extreme, ReCap includes other types of formal transactions in addition to strategic alliances [see subsection 4.1.2.3]. Finally, other (intra-sample) alliance-related announcements may complement these two sources.

Figure 34: Frequency of Focal Firm Alliance Experience and Repeat Interactions

(a) Focal Firm Alliance Experience



(b) Prior Collaborative Relations to Partner



Data Source: Own Analysis

Together, the various transaction, environmental, and firm-level variables detailed in this subchapter provide the data pool for the empirical analysis.[356] Before proceeding to the results of the data analysis, however, the employed econometric methods will be specified.

4.3 Event Study Procedure

The present study analyzes the announcement effects of alliance-related news. A wealth of prior literature has generated, discussed and analyzed various versions the event-study approach to vigorously analyze the value impact of unanticipated news announcements.[357] This section focuses on the procedures applied in the subsequent analyses, but refers to alternatives

356 Table 100 and Table 101 of the appendix provide overviews of the variables matched to the proposed controls and hypotheses, respectively. As further illustrated in Table 102, multiple variables may proxy for core controls to increase the validity and reliability of inference. Finally, Table 103 summarizes the data sources used in the present study.

357 Several authors have provided overviews of the methodologies used in event-study research. (Bowman 1983), (Peterson 1989), (Strong 1992), (Armitage 1995), (MacKinlay 1997), (McWilliams and Siegel 1997), and (Bhagat and Romano 2001), among others. Another line of literature provides evidence on the performance of alternative event-study methodologies. This includes (Brown and Warner 1980, 1985)[357] as well as (Cable and Holland 1999).

and the rationale for their omission.[358] It first presents the general set-up of an event study (4.3.1), before turning to the choice of parameters (4.3.2) and the underlying assumptions (4.3.3). Section 4.3.4 concludes.

4.3.1 Econometric Event Study Methodology

On the most general level, the event study employs a logic pursuant to Equation (4) below. That is, for any given day and security, the deviation of the observed from the expected returns is represents the abnormal (i.e., unexpected) return, which may be attributed to events occurring on or around the given day.

$$AR_{i,t} = R_{i,t} - E\left(R_{i,t}\right) \tag{4}$$

with
$AR_{i,t}$ = Abnormal Return for Given Security i and Day t
$R_{i,t}$ = Observed Return for Given Security i and Day t
$E(R_{i,t})$ = Expected Return on Security i for Day t

An event-study analysis consists of three distinct steps: First, the expected (i.e., normal) return on the security(-ies) under observation is estimated (4.3.1.1).[359] Second, ARs are specified, which may entail averaging, summation, and/or standardization (4.3.1.2). Third, the ARs are tested for their statistical significance (4.3.1.3).

4.3.1.1 Alternative Return-Generating Processes

Prior literature has applied a variety of approaches to approximate the return generating process, i.e., the appropriate estimation model for the ex-

358 Table 75 provides an overview of the methodological approaches used by various researchers in alliance-related event studies. Individual studies are primarily referred to in the main text for illustrative purposes.

359 An initial step before commencing the actual event study is deriving the raw returns on focal securities, i.e., $R_{i,t}$ in Equation (4). Calculation mechanisms may be either discrete or logarithmic in nature [see Equations (23) and (24) of the appendix]. As summarized by (Strong 1992), logarithmic returns may be more likely normally distributed, thus more easily fulfilling the assumptions of standard statistical and econometric techniques. However, empirical research has employed both approaches rather interchangeably and often without explicit reference to choice of return used. The present study tested both discrete and logarithmic returns without encountering significant differences in results. All results reported in the main text are based on discrete returns. Other authors choosing discrete returns include (Karamanos 2002).

pected returns [$E(R_{i,t})$ in Equation (4)].[360] The present study relies on the market model, market adjustment, and multi-factor model procedures. It skips mean adjustment and economic models, which are not commonly used in an alliance-related context and impose strong assumptions on the estimation procedure (e.g., firms' mean stock returns being constant over time).[361]

Standard Market Models

The most commonly used approach to estimating expected returns goes back to (Fama et al. 1969).[362] The market model incorporates both firm- and market-specific risk-factors by estimating the focal firms' risk exposure relative to the market over an estimation period unaffected by the focal event [Equation (5)]. The derived factor is then applied to the observed market returns for the given event day to compose the expected return [Equation (6)]. The market model thus accounts for the overall market return on the event day as well as the average sensitivity of focal firm returns to market movements.

The popularity of the market model in event-study research is supported by a generally positive assessment of its power[363] and reliability. Specifically, (Dyckman et al. 1984) report that it significantly outperforms mean- and market-adjusted return models. At the same time, (Cable and Holland

360 Table 75 of the appendix includes information on the event-study (and cross-sectional) methodologies used by prior alliance-related research.

361 Table 104 of the appendix discusses the methods not employed in the present event study, which substantiates the choice of methods used. Furthermore, benchmarking exercises have been used to approximate expected returns. For instance, (Fama and MacBeth 1973) compile portfolios based on ß-factors and use the observed return on the relevant portfolio as the expected return. Such methodologies are quite common in long-run event studies [cf. (Barber and Lyon 1997)], but rarely used in work on announcement effects. Consequently, this direction is not pursued further.

362 While earlier studies have also addressed the stock-market impact of certain events, (Fama et al. 1969) are often credited with having established the event study as a research methodology. (Campbell et al. 1997), however, refer to (Dolley 1933) as being "perhaps the first published study" (p. 149) and provide an overview of studies during the 1940s, 50s, and early 60s. Additionally, (Ball and Brown 1968) also published an event study.

363 Whenever this study mentions (statistical) power of a procedure or test, it refers to the ability of the given method to avoid type-1 errors (i.e., falsely rejecting the assumed insignificance of relationship). This does not necessarily render it a better better test or procedure, if it leads to excessive type-2 errors (i.e., failing to identify a significant relationship).

1999) suggest that the market model possesses higher explanatory power than CAPM. Concurrently, the market model is the predominantly used approach in the context of the present study. With few exceptions using CAPM [Sleuwaegen et al. (2003)], mean adjustment [Ravichandran/Sa-Aadu (1988)], market adjustment or multi-factor models (see below), all alliance-related event studies rely the standard market model.

$$AR_{i,t} = R_{i,t} - \left(\alpha_i + \beta_i R_{m,t}\right) \tag{5}$$

with:

α, β coefficients of the following one-factor OLS regression model estimated over a relevant estimation period:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \tag{6}$$

Market-adjusted Return Model
The market-adjusted return model disregards any firm-specific influences in favor of market developments. As illustrated in Equation (7), the expected return on a given security equals the return on a relevant market index for the same day. It thus represents a restricted version of the standard market model (see above) with α and β set to zero and one, respectively.[364]

$$AR_{i,t} = R_{i,t} - R_{m,t} \tag{7}$$

with:

$R_{m,t}$ = Return on relevant market index for day t

Evidence on the performance of market-adjusted returns is limited but better than for mean-adjusted returns. In particular, (Brown and Warner 1985) find that the resulting ARs are similar to those of regression-based models. (Cable and Holland 1999) support the explanatory power of the market-adjusted return model in some cases, but it remains inferior compared to market and economic models. Still, market adjustment has been at times

[364] For market adjustment to be valid, the index used should thus closely reflect the systematic factors driving the returns on all focal companies. That is, in country-/industry-specific settings, country/industry indices may more strongly reflect systematic risk factors than broad, international indices.

used in collaboration-related event-studies [most notably, (Woodridge and Snow 1990) and (Karamanos 2002)].[365]

Multi-Factor Models

A nearly unlimited variety of alternative models may be specified to incorporate additional information in the expected returns. Multi-factor models expand the standard market model by incorporating several explanatory variables [i.e., β in Equations (5) and (6)] becomes a vector of coefficients and $R_{m,\,t}$ is replaced by a matrix of independent variables).

Most commonly, such multi-factor models are founded on the notion that commonalities among firms in industry association or other firm characteristics have a systematic impact on (normal) stock returns.[366] In the context of alliance-related event-studies, (Park et al. 2004) and (Janney and Folta 2003) employ a two-factor approach combining a general market and an industry index. Similarly, (Neill et al. 2001) use a two-factor model incorporating a size-adjustment. Finally, some authors [e.g., (Park and Martin 2001) and (Park 2004) in the context of global airline alliances] have proposed the world-market-model for global event studies, in which returns may be affected by global and national market as well as exchange-rate movements. Given the cross-national, single-industry setting of the present study, a multi-factorial approach may enrich the event-study analysis by distinguishing general economic (or country-specific) and industry-specific drivers of stock returns.[367]

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365 Constraining α and β homogenizes the sensitivity to market movements. When an intra-sample index is used as a market proxy, this reduces potential biases arising from individual firms heavily weighing into the market index (see section 4.4.2). Therefore, market adjustment will be employed in combination with the intra-sample index, but not indices less prone to endogeneity bias.

366 (MacKinlay 1997) refers to (multi-)factor models as attempts to reduce the variance of the abnormal returns by explaining a larger share of variation in the normal returns. However, he concludes that the benefits of utilizing multi-factor models in event-study settings are usually marginal. Specifically, they will “typically be greatest in cases where the sample firms have a common characteristic, for example they are all members of one industry or they are all firms concentrated in one market capitalization group” (p. 18).

367 (Campart and Pfister 2003) outrightly use pure (pharmaceutical and biotechnology) industry indices. Evidence on the advantages of using industry-specific indices instead of or concurrently with general market indices is mixed. While (Thompson 1988) found results to be highly similar, (Sharpe et al. 1999) suggest the industry-specific influences may be important.

In summary, the standard market model has proven effective in event studies and has been employed by the vast majority of prior alliance-related work. Among alternative models, only the multi-factor model holds the potential for greater explanatory power.

4.3.1.2 Specification of Abnormal Returns

The return generating process delivers an estimate of the expected returns for each day of the event period [i.e., $AR_{i,t}$ in Equation (7)]. These abnormal returns may be averaged, cumulated, and standardized to allow more detailed analysis.[368]

The handling of non-standardized ARs is straight-forward: First, the average abnormal returns (AAR) for a given day during the event period are calculated as the arithmetic mean across all events. Second, ARs for a given security on several (subsequent) days during the event period may be aggregated to form cumulative abnormal returns (CAR), i.e., the sum of daily ARs. Third, AARs may be summed over several event-period days or CARs may be averaged over several securities to yield cumulative average abnormal returns (CAAR).

Since unstandardized abnormal returns have quite different prediction errors, comparing them across observations and time periods may induce substantial biases. Consequently, standardization sets the observed abnormal returns in relation to their estimated forecast error. Given the impossibility of directly observing such errors, several approximations have been used in prior research. Among others, (Peterson 1989) suggests the standard error of the focal security's mean return in the estimation period (time-series standardization) and the cross-sectional variation in ARs across all sample firms on a given day of the event window (cross-sectional standardization). While the former corrects for the individual security's specific variation, the latter accounts for the market's overall variation. At the same time, the former draws only on data from the estimation period, whereas the latter exclusively relies on event-period data.[369]

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368 To conserve space, the general arithmetic equations used to average, aggregate and standardize abnormal returns are presented in the appendix [Equations (25) to (31) of the appendix].

369 The most commonly used standardizations [following (Dodd and Warner 1983) and (Brown and Warner 1985)] primarily form the basis of specific testing procedures and will thus be addressed in the following subsection. While the (Dodd and Warner 1983) test builds on the time-series standardization approach, whereas the (Brown and Warner 1985) test effectively standardizes average market returns.

The present study used both of these standardization approaches.[370] In addition to the tests discussed in the following subsection, all cross-sectional analyses conduced on standardized measures yielded similar findings as those on raw ARs.

4.3.1.3 Testing for the Significance of Abnormal Returns

Once ARs have been specified, most studies employ formal tests regarding their statistical significance [i.e., the likelihood of ARs (CARs, SCARs etc.) being different from zero]. Such tests may primarily relate the absolute (parametric) value of observations or their (non-parametric) sign. Parametric tests place the observed ARs in relation to measures of variation, whereas non-parametric tests generally rely on rank orders.

In addition to standard approaches (e.g., parametric t-tests and non-parametric sign tests), specific tests have been developed for the application in event-study contexts. As these test statistics relate to different variation benchmarks, the present study concurrently uses four of them to yield a comprehensive conclusion on the significance of ARs: the parametric proposed by (Dodd and Warner 1983) and (Brown and Warner 1980), a cross-sectionally standardized test as well as the non-parametric test developed by (Corrado 1989).[371]

(Dodd and Warner 1983) Z-Test

The Dodd-Warner approach standardizes ARs by a measure of variation derived from the estimation period [Equation (8)]. Expanding on simple time-series standardization, the standard deviation is adjusted to account for differences in market returns between the event day and the estimation period.

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[370] Standardized abnormal returns (SAR) may also be averaged for given event days (SAAR) and aggregated for given securities (SCAR) as well as averaged and cumulated over several days and securities (SCAAR). The arithmetics are somewhat more complicated in this case. See Equations (28) to (31) of the appendix for details.

[371] More advanced tests are available, but event-study research has thus far not applied them in an alliance-related context. One notable exception is the work by (Bayona et al. 2002b, 2002a), who employ the parametric test proposed by (Boehmer et al. 1991) in addition to the Corrado test. While the Boehmer test is more comprehensive than any of the ones used in the present study, the Dodd-Warner and crossectionally standardized tests combinedly account for the same sources of variation and allow to distinguish between time-series and cross-sectional variation. Table 105 further elaborates on the test statistics not used in the present study.

$$S\left(AR_{i,t}\right)=\left\{S_i^2\left[1+\frac{1}{L_i}+\frac{\left(R_{m,t}-\overline{R}_m\right)^2}{\sum_{t=1}^{L}\left(R_{m,\tau}-\overline{R}_m\right)^2}\right]\right\}^{0.5} \tag{8}$$

with

S_i = Standard Deviation of Residuals in Market Model (or other return generating process)

$R_{m,\, t/\tau}$ = Return on the Market Index for day t (event period) or τ (estimation period)

R_m = Mean Return on the Market Index during the estimation period

The Dodd-Warner approach thus accounts for both security-specific and general market sources of AR variation, however, without explicitly including cross-sectional variation. The SARs are then cumulated and averaged to arrive at SCAARs. The test statistic is:

$$\Theta_{\tau_1,\tau_2}=SCAAR_{N,T}\times\sqrt{N} \tag{9}$$

with:

N = Number of Observations

T = Number of Days in the Event Period

While quite powerful, the Dodd-Warner test does not account for some sources of variation, which may render it susceptible if used exclusively. Specifically, such influences may be the clustering of events in time, systematic differences in stock (and thus AR) volatility between estimation and event periods, and the non-normality of ARs (also see section 4.3.3 on the assumptions underlying the event-study method). The three additional test statistics used in the present work are capable of mitigating these shortcomings.

(Brown and Warner 1985) Z-Test

This methodology calculates a time-series measure of variation for the entire sample.[372] In particular, the standard deviation reflects the variation in average ARs across all days of the estimation period [Equation (10].

372 Note that while the methodology is generally referred to as Brown-Warner, it was by not developed in (Brown and Warner 1985). A list of prior studies em-

$$s\left(AAR_t\right)=\sqrt{\frac{\left(\sum_{t=1}^{L}\left(AAR_t-\overline{AAR_L}\right)^2\right)}{L-1}} \tag{10}$$

with:

$$\overline{AAR_L}=\frac{1}{L}\sum_{t=1}^{L}AAR_t$$

and:

L = Number of Days in the Estimation Period

Based on this standard deviation, the Brown-Warner test statistic may be calculated for individual event days or multi-day event periods

$$\Theta_t=\frac{AAR_t}{S\left(AAR_t\right)} \tag{11}$$

$$\Leftrightarrow$$

$$\Theta_{\tau_1,\tau_2}=\frac{\sum_{t-\tau_1}^{t-\tau_2}AAR_t}{\left(\sum_{t=\tau_1}^{t-\tau_2}s^2\left(AAR_t\right)\right)^{\frac{1}{2}}}$$

with:

τ1 = First Day of the Event Window

τ2 = Last Day of the Event Window

Since the estimated standard deviation of abnormal returns is constant across event days, the latter is equivalent to:

$$\Theta_{\tau_1,\tau_2}=\frac{\sum_{t-\tau_1}^{t-\tau_2}AAR_t}{\left[\left(\tau_2-\tau_1+1\right)s^2\left(AAR_t\right)\right]^{\frac{1}{2}}} \tag{12}$$

(Brown and Warner 1985) summarize that the test statistic(s) is (are) distributed Student-t if the AARs are independent, identically distributed and normal. Given large degrees of freedom, the distribution may also be as-

ployed similar test statistics. Moreover, the portfolio standard deviation may also be used to first standardize abnormal returns [e.g., (Jaffe 1974)].

sumed unit normal, which is why Brown-Warner test statistics are often referred to as Z-tests.

The Brown-Warner methodology has the favorable property of building on aggregate market returns. As the assumed independence of observations may be compromised in the case of event clustering, the Brown-Warner statistic presents an important complement to the more powerful Dodd-Warner test.[373]

Cross-Sectionally Standardized Test

Both (Dodd and Warner 1983) and (Brown and Warner 1980) effectively use time-series standardization techniques (at individual firm and aggregate market levels, respective). As this approach relates event-period returns to estimation-period variance measures, these tests may be biased under conditions of event-induced variance increases (i.e., increases in the cross-section variation during event periods). Cross-sectional standardization may fill this gap, since it considers only the event-period variation in ARs.

Implementing the cross-sectionally standardized test is quite simple [see (Armitage 1995)]. (1) The standard deviation of individual firm ARs is then calculated for each event day. (2) This is used to standardize the individual ARs for that given day. (3) The SARs are averaged, cumulated, and used to construct a test statistic similar to Equation (11).

Surprisingly, only (Gleason et al. 2003) tests the significance of cross-sectionally standardized abnormal returns in the context of alliance formation.

Corrado Rank Test

If ARs are non-normally distributed, the explanatory power of the three parametric tests proposed above may be limited. In contrast, non-parametric statistics are unaffected by deviations from the normality assumption. As a result, many researchers have concurrently used parametric and non-parametric significance tests [e.g., (McConnell and Nantell 1985), (Reuer and Miller 1997)].

(Corrado 1989) proposes a rank test building on the time-series distribution of focal securities' ARs, rather than their cross-sectional distribution

373 The Brown-Warner test has been widely applied in in alliance-related event studies, including the recent work by (Brooke and Oliver 2004), (Garcia-Canal and Sánchez-Lorda undated), (Meschi and Cheng 2002), and (Wang and Wu 2004).

(as do sign or standard rank tests).[374] In particular, the variation of ARs is considered across both the estimation and event periods. Firms' ARs are ranked across all days of the combined time period. To construct the test statistic [Equation (13)], these ranks are centered on their median and averaged across observations [Equation (14)] as well as divided by their standard deviation [Equation (15)].

$$\Theta_t = \frac{AD_t}{S\ (AD)} \tag{13}$$

with:

$$AD_t = \frac{1}{N}\sum_{i=1}^{N}\left\{K_{i,t} - \left[\frac{(T+1)}{2}\right]\right\} \tag{14}$$

and

$$S\ (AD) = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(AD_t)^2} \tag{15}$$

and

$K_{i,t}$ = Rank of the Return on Security i on day t within the combined estimation and event period

(Corrado 1989) and (Corrado and Zivney 1992) provide evidence of the Corrado rank test outperforming simple sign- and parametric t-tests. Additionally, (Corrado and Zivney 1992) show that the Corrado test may be better suited to event-induced variance changes than the parametric test.

In summary, the four test statistics used in the present study combine to account for all relevant sources of AR variation, including violation of the independence, constant variance, and normality assumptions. Valuation effects found to be significantly different from zero by the entire battery of tests thus benefit from substantially validation.

4.3.2 Benchmarks, Estimation and Event Periods

While the econometric and statistical procedures detailed in the preceding section are quite standardized, several input parameters have to be chosen

[374] Standard sign and Wilcoxon-Signed-Rank tests were also used in the present study to validate the documented effects. Their results (not reported) did not significantly from those for the Corrado test.

without clear methodological guidance. Consequently, the present section outlines the stance prior research has taken on the choice of market indices, estimation, and event periods to guide the own empirical study.

4.3.2.1 Choice of Market Indices

All three return generating processes employed (4.3.1.1) rely on a measure of market performance. As these models only specify the relationship between the market indices and the ARs, they can be employed using different indices.[375]

In general, indices differ in the breadth of their constituency and their relative weight (i.e., they may be market-wide or selective as well as equally or value-weighted). For monthly data, (Brown and Warner 1980) provide evidence of equally-weighted indices slightly outperforming value-weighted ones. Contrarily, (Krueger and Johnson 1991) suggest that both may perform similarly well.

In alliance-related event studies, broad market indices are often used, including both all-share indices as well as selective indices with a fairly broad constituency (e.g., S&P 500). The choice of equal- or value-weighting is handled liberally.[376] Outside the U.S., the picture appears even more diverse, with the indices used ranging from value-weighted all-share [e.g., (Chang and Kuo undated)] to selective blue-chip indices [e.g., (Meschi and Cheng 2002)].

Given that market models (and market-adjusted return models) are free from such assumptions, the 'best suitable' indices should merely exhibit a sufficiently stable relationship to the focal firms' stock returns. Consequently, the great variety of indices used in prior research may not be very harmful.[377] The present study first analyzes the relationship between mar-

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[375] Conversely, some economic models endogenously require specific market indices Most notably, the CAPM model explicitly incorporates the market portfolio. Theoretically, this would be a value-weigthed index of all capital assets available. Practically, however, researchers have relied on 'pure' stock-market portfolios (i.e., value-weighted index of all stocks).

[376] For instance, (Anand and Khanna 2000) and (Kale et al. 2002) use the value-weighted S&P 500 index, whereas (Gulati and Wang 2001) use an equally weighted version. Other authors rely on value- [e.g., (Neil et al. 2001)] or equal-weighted [e.g., (Houston 2003)] CRSP all-share indices.

[377] To the extent that ß measures the firm-specific covariation with the market overall, as assumed by CAPM, equal-weighted indices or those comprising only a limited number of securities would be incorrect choices and might lead to biased estimates of abnormal returns. At the same time, the relatively broad indices most commonly used (e.g., S&P 500 or all-share indices) may not be

ket and individual stock returns (see section 4.4.2), before settling on specific benchmark indices.

4.3.2.2 Choice of Event and Estimation Periods

Similar to the choice of benchmark indices, the choice of estimation and event periods appears to be at the liberty of the individual researcher:

- Generally, the estimation period should be long enough to allow a stable estimation of market (or other) model parameters. At the same time, it should be far enough removed from the announcement date to be unaffected by the even, yet close enough to reduce the risk of estimation parameters having changed from the estimation to the event period [cf. (Strong 1992), among others]. In practice, the estimation window ranges from 70 [(Sleuwaegen et al. 2003)] to 250 [(Park and Kim 1997)] days ending anywhere from 5 [(Socher 2004)] to 61 days [(Chen et al. 2000)] prior to alliance announcement.[378]
- Regarding the length of the event window, (McWilliams and Siegel 1997) argue that it should be chosen carefully with preference being given to shorter periods. Specifically, they summarize that longer event windows may bias the estimated significance of abnormal returns by overly reducing the power of standard test statistics, since news is usually rapidly incorporated into market prices. In alliance-related event studies, event windows differ greatly. While some authors use only announcement-day ARs, others extend the event window to 21 [(Meschi and Cheng 2002)] or even 25 days [(He et al. 1997)]. Most commonly, two-day (-1 to zero), three-day (-1 to +1), and five-day (-2 to +2) windows are used.

While the choice of estimation and event windows may have a significant impact on abnormal return estimates, prior literature has not provided clear-cut guidelines. In following the mainstream of research, the present study employs a 200-day estimation window and several different event windows. As shown in Figure 35, the observation period (i.e., the largest

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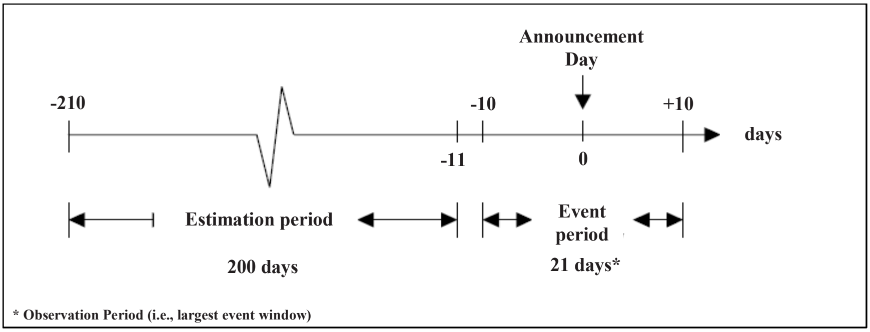
sufficiently representative for studies more narrowly focusing on specific industries or types of firms.

378 Some authors also use estimation windows centered over the event date [e.g., (McConnell and Nantell 1985), (Ravichandran and Sa-Aadu 1988), (Gupta and Misra 2000)], as this approach may be more robust to changes in the model parameters induced by the event. As prior research provided little evidence of persistent changes in stock volatility following alliance announcements [cf. (Arend 2004)], the present study used the standard order of estimation period preceding the event period.

event window) comprises 21 days centered around the announcement day. To reduce the impact of confounding events and noise, a 2-day window (-1 to 0) will be used for the cross-section analysis [see (McConnell and Nantell 1985), (Koh and Venkatraman 1991), (Chen et al. 2000), (Gleason et al. 2003) as examples using a similar window].

Figure 35: Estimation and Event Periods in Own Event Study



Source: Own Illustration [based on (Peterson 1989)]

4.3.3 Assumptions Underlying the Event Study Methodology

Due to the multi-staged process of conducting an event study, the tests for significant ARs (or cross-sectional determinants of ARs) are affected by the preceding analytical steps and represent joint tests of more than one effect. Two types of assumptions are implicitly included in event-study analyses: One arising from the general logic of the approach itself (0)and another due to the econometric implementation of expected return predictions and statistical testing procedures (4.3.3.1).

4.3.3.1 General Event-Study Assumptions

Conceptually, researchers using the event-study methodology assume that all abnormal stock returns observed on or close to the announcement date to reflect the valuation effect of the information transmitted. More specifically, (McWilliams and Siegel 1997) as well as (McWilliams and Siegel 1997) list three general assumptions underlying the identification of abnormal returns:[379]

[379] For more extensive discussions and critiques of the event-study method, see (Bromiley et al. 1988), (Sawyer and Gygax 2001)

- Market efficiency requires that novel information is seamlessly incorporated into stock prices, i.e., prices quickly and adequately adjust to relevant news.[380] This assumption allows interpreting the observed ARs as induced by and reflecting the true value impact of the events studied. Given that the market is sufficiently efficient, the news items conveying relevant information will lead abnormal price-reactions, whereas irrelevant news will have no significant effect. While the efficient market hypothesis (EMH) has been challenged on various grounds, including overreaction or herding effects, systematic size effects, and day-of-the-week effects, most major capital markets are at least moderately efficient.[381]
- Given a sufficiently efficient market, expectations regarding future events are ex ante incorporated into market prices. Therefore, only unanticipated events will cause significant market reactions. More precisely, the observed ARs only reflect the unanticipated information content of a given event. Consequently, the valuation effects may be biased, if the market has differentially anticipated observations or particular transaction characteristics. While conceptually clear, this aspect has generally not been considered in empirical work.[382] The present study takes one step in this direction by accounting for self-selection in alliance formation, which also may reflect market anticipation of such events.
- If other news arise simultaneous or close to the event announcements studied, the distinct influences of the various events may be inseparable. Consequently, any ARs recorded during periods affected by other than the focal events are biased and cannot be attributed to the focal events. As a result, controlling for confounding effects is standard practice in event-study research. Typically, events are excluded from analyses if a news search yields other potentially relevant news items during the cho-

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380 More specifically, the event-study approach requires capital markets to accurately value any *publicly available* information (moderate efficiency). (Fama 1970) provides an overview of the early market efficiency literature.

381 For empirical evidence supporting the information efficiency of Eurpean capital markets. (Bromiley et al. 1988) provide a summary of the potential limitations to capital market efficiency. More recently, (Fama 1998) argues in favor of capital markets being fundamentally efficient in spite of short-term deviations.

382 One notable exception in the present context is the work by (Madhavan and Prescott 1995), who link the value impact of alliance formation announcements to the information processing load, which may in turn reflect the anticipatory ability of the market. See section 4.5.3 for a broader discussion of selection and over-sampling biases in the present context.

sen event window. Such confounding events include but are not limited to M&A transactions, earnings and dividend announcements, new product introductions as well as top-management turnover.

While the efficiency of capital markets, events being unanticipated, and the absence of confounding news are fundamental assumptions of the events-study method, they should thus either be given (e.g., EMH) or can be accounted for in the empirical methodology (e.g., confounding events).

4.3.3.2 Distributional/Statistical Assumptions

In applying econometric and statistical procedures required to derive and test abnormal value effects, researchers buy into the assumptions underlying these methods. Three fundamental assumptions relate to the stock returns used in calculating abnormal performance:

- The statistical assumptions of regression-based return models include stock returns being multivariate normal and independently and identically distributed across time. As (MacKinlay 1997) notes, "while this distributional assumption is strong, in practice it generally does not lead to problems because the assumption is empirically reasonable and inferences using the normal return models tend to be robust to deviations from the assumption" (p. 17). Among others, the simulation-based research by (Brown and Warner 1985) provides evidence supporting this assessment regarding normality. As a result, few researchers have actively tested the distribution of stock and index return data prior to conducting an event study.[383]
- The assumption of independent asset returns may be violated, when event dates are inhomogeneously distributed in time. Specifically, events clustered on or around certain dates will be subject to interdependencies. As outlined by (MacKinlay 1997), aggregating the abnormal returns of clustered and unclustered events may result in biased results. Early event-study research, e.g., by (Jaffe 1974) and (Mandelker 1974), suggested aggregating clustered events into portfolios, whose returns are independent from each other. These as well as other procedures[384] designed to mitigate the effects of cross-sectional interdepend-

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383 See section 4.5.1 for a more general treatment of the assumptions underlying OLS regression models.

384 An alternative method accounting for cross-correlated abnormal returns in addition to other potential sources of biases (i.e., systematic differences in abnormal returns between securities and between estimation and event periods) is generalized least squares (GLS) estimation. As (Armitage 1995) points out, however, this approach requires more estimation window observations for

ence are essential, when event clustering is pervasive (e.g., annual return announcements). In other settings, the independence assumption generally is upheld and may in fact not be harmful [e.g., (Brown and Warner 1985)].[385]

- The estimation of time-series parameters in regression-based return models assumes sufficiently frequent trading activity. The estimated beta coefficients for shares, whose returns are non-synchronous to market returns will be biased, which in return may induce bias into the derived ARs [cf. (Peterson 1989), (Strong 1992)]. Prior research has elaborated several approaches to correct for non-synchronous trading, with the (Scholes and Williams 1977) and (Dimson 1979) procedures being most prominent.[386] However, these approaches only apply to systematic differences in trading frequency, whereas occasional missing data may be corrected for by using only returns for time-periods not affected by missing data.[387]

The distributional assumptions of regression-based models, the absence of event clustering, and stock price synchronism thus underlie all regression-

each event than there are events to be estimated. This further with the number of explanatory variables and accurate estimation necessitates even larger data sets. This often renders such an approach impractical, since it would require estimation windows far longer than can be realistically assumed to yield consistent parameter estimates.

385 Specifically, the simulations by (Brown and Warner 1985) show that neglecting positive cross-sectional dependence (i.e., covariance) leads to “a systematic underestimation of the variance of the mean excess returns, implying too many rejections of the null hypothesis, both when it is true and when abnormal performance is present” (p. 20). While this would reduce the risk of type-1 errors, correcting for cross-sectional correlation in cases without clustering may induce a reverse bias, i.e., underestimating the significance of existing abnormal returns (type-2 error) [also see (Brown and Warner 1980), Dent and Collins (1981)].

386 While these procedures may successfully reduce the (downward) bias in infrequently traded stocks’ beta-coefficients, (Brown and Warner 1985) suggest that the gains in accuracy may be marginal. Specifically, they argue that, for samples reflecting a broad range of trading frequencies, the average bias in ARs will be close or equal to zero. Moreover, in the time-series, the average bias for each firm will be equal to zero, since a downward (upward) bias in the beta-coefficient will be compensated by an inverse bias of the alpha-coefficient.

387 As noted by (Peterson 1989), removing the missing period and the subsequent period returns from the analysis also removes any potential biases from the raw return data, while maintaining a maximum number of (unbiased) observations. Such an approach is also used by (Brown and Warner 1985).

based event studies. Potential shortcomings may be accounted for using appropriate estimation (e.g., handling of missing returns) and testing procedures (e.g., non-independence; see subsection 4.3.1.2).

4.3.4 Summary and Discussion

This section has provided an overview of the employed event-study methodology. Where appropriate, it has also documented the choices other researchers have made in the strategic-alliance field and discussed possible advantages of the present study's approach:

- Given the evidence favoring regression-based return generating processes, the present study primarily relies on standard market and multifactor models. Only for indices heavily weighing some sample firms, market adjustment may be preferable.
- Little if any evidence exists favoring particular choices of event and estimation windows as well as benchmark indices. The present study uses a 200-day estimation period and several different-length event periods, the largest of which extends to 21 days.
- With regard to statistical significance tests, prior alliance-related event studies have extensively relied on standard methodologies, in particular t-tests, Brown-Warner tests, and non-parametric Sign- or Rank-tests. Favoring more powerful tests and accounting for potential sources of biases, the present study uses the Dodd-Warner test in combination with the Brown-Warner, cross-sectional, and nonparametric Corrado procedures.
- Finally, all event studies represent joint tests regarding the hypothesized effects and the implicit assumptions made along the way. Most prerequisites should be given in the present setting, but the distributional characteristics of stock and index returns as well as event dates may need to be empirically tested.

The following sections lay the groundwork for the event study itself by analyzing the statistical properties of the relevant stock and index return series and evaluating different market indices as benchmarks for the event study.

4.4 Time-Series Analysis

The objective of this initial data analysis is to better understand the factors driving the performance of European DBF stocks. Specifically, this requires differentiating country- and industry-specific influences from more general market movements. This may serve to assess the appropriateness of indices or combinations of indices to be used in the estimation of expected returns.

For this purpose, the available time series data on stock and index returns will be analyzed using time series methodologies. This encompasses two distinct steps: Tests regarding the properties of the return data (section 4.4.1) and the estimation of appropriate time-series regression models and analyses regarding their quality of estimation (section 4.4.2).

4.4.1 Time-Series Data and Tests

In this section, the most common violations of time-series regression assumptions are tested based on data for the time period 1996-2003,[388] including non-normality, serial correlation, non-stationarity, and GARCH effects.

4.4.1.1 Retrieval of Stock and Index Return Data

The most general input required for conducting an event study are the daily (or monthly) returns on focal firms' stocks as well as on benchmark indices. Unfortunately, prior research does not provide a unanimous guideline on sourcing such data. For event studies involving U.S. firms, stock prices are generally provided by the Center for Research in Security Prices (CRSP). International studies often only refer to one country and thus may rely on country-specific data sources.[389] In line with several European (and international) event studies, the present work obtained stock and index data from Thomson Financial's Datastream.[390] To ensure the data validity, several precautionary measures were employed:

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[388] Stock-return data for 1996 is included, because the estimation windows for some events in early 1997 extend back into 1996. It thus is only prudent to also include this year in the time-series analysis.

[389] Only (Park and Martin 2001), (Kim and Park 2002), (Meschi and Cheng 2002), and (Meschi 2005) study alliance-related events across a number of different countries. All of these studies use country-specific indices as benchmarks either by themselves or as part of the world market model, i.e., also accounting for global stock-price and exchange-rate movements.

[390] While many researchers do not report the source of their stock and index return data, most non-U.S. studies rely on Datastream, including (Park and Martin 2001), (Kim and Park 2002), (Campart and Pfister 2003), (Brooke and Oliver 2004), (Socher 2004)/(Häussler 2005)/(Häussler 2006), and (García-Canal and Sánchez-Lorda Undated).

- The price and return data was validated using the corresponding data from Reuters™ database. In addition to stock-price data generally being congruent, any observed deviations in the provided return data were minor.[391]
- Since Datastream extrapolates price and return values for non-trading periods, the data had to be corrected for non-trading, i.e., values merely being carried forward were dropped from the dataset to avoid zero-return observations.[392]

4.4.1.2 Normality Tests

As discussed for event-study applications in subsection 4.3.3.1, regression-based time-series methods assume normal distribution for statistical inference (i.e., for assessing the significance of coefficients and measures of model quality).

All stock-return time series were tested for normality using multiple tests. On one hand, the test proposed by (Shapiro and Wilks 1965) was applied as an aggregate normality measure; skewness and kurtosis were also separately tested. On the other hand, normal plots of the time-series variables were visually examined for evidence of non-normality. Both formal and visual tests yielded the conclusion that the time series of stock returns are non-normally distributed, due to both non-zero skewness and kurtosis.[393] As shown in Table 5, only one time series (Qiagen) does not exhibit

[391] While price data is only adjusted for stock-splits, return data incorporates a number of different factors, including dividend payments and other sources of shareholder returns. As these adjustments may vary between different data sources and dividend payments are of low importance in the biotechnology sector, the present study used price data for its primary analyses. To ascertain validity, all analyses were repeated using the return data retrieved from Datastream, without encountering substantial differences in the results.

[392] Specifically, returns had to fulfill one of two conditions. On the one hand, data was included when the record showed trading activity for the given day. On the other hand, return data indicating changes in value (i.e., deviating from the previous day's value) were included even if no trading volume was shown in the record. Omitting these returns would result in a type-2 error, i.e., viable observations being falsely excluded. In particular, no trading volume was available for some earlier time-periods, although they exhibited variation in stock returns. All complementary stock-related data, including trading volume, market value etc. were also obtained from Datastream.

[393] Note that since the normal distribution is fully described by the first and second moments (mean and standard deviation), any evidence of latter moments (skewness and kurtosis) violates the assumption of normality.

significant skewness, but all stock return series are leptokurtosic and non-normal. Evidence on the index time series was slightly more favorable with regard to skewness, but equally unambiguous in terms of non-normality in general.[394]

Table 5: Results of Normality Tests for Stock and Index Return Time-Series

Time Series	No. of Time Series	No. Rejecting Skewness*	No. Rejecting Kurtosis*	No. Rejecting Normality* (Shapiro-Wilks)
Stock Returns	46	45 (97.8%) 45 (97.8%) 45 (97.8%)	46 (100%) 46 (100%) 46 (100%)	46 (100%) 46 (100%) 46 (100%)
Index Returns	17	7 (41.1%) 9 (52.9%) 11 (64.7%)	17 (100%) 17 (100%) 17 (100%)	17 (100%) 17 (100%) 17 (100%)
All Series	63	52 (82.5%) 54 (85.7%) 56 (88.9%)	63 (100%) 63 (100%) 63 (100%)	63 (100%) 63 (100%) 63 (100%)

* From top to bottom, number of rejections shown at 1, 5, and 10% levels of significance

4.4.1.3 Serial Correlation Tests

Similar to the case of non-normality serial (or auto-)correlation reduces the validity of time-series inferences. In this context, autocorrelation refers to the violation of the assumed randomness (i.e., independence) of error terms. Unless an interdependence between successive error terms (e.g., ε_t and ε_{t-1}) is accounted for, the estimated time-series parameters will not be efficient, i.e., their standard errors will be unpredictably biased.[395]

394 For further details, Table 106 in the appendix provideS the individual test results. Figure 59 shows examples of normal plots reflecting the non-normality even in those time series having the lowest, albeit significant skewness and kurtosis. The indices used in the present study are shown in Table 107 of the appendix.

395 Cf. (Gujarati 2003), pp. 393-400.With regard to market model estimation, however, the (α and β) estimators remain consistent and unbiased. The loss in efficiency due to biased variance measures is not a major problem, since the

The most commonly used test for autocorrelation, the Durbin-Watson d-test,[396] was applied to all stock and index time-series. As the d-test itself is based on a regression approach, it entails the assumption of normally distributed error terms. Given their above documented non-normality, the non-parametric Runs-test is used to validate the evidence provided by the Durbin-Watson d-tests.[397]

The results of the two tests are reported in Table 6. Surprisingly, the two tests differ in their findings. While the Durbin-Watson d-test consistently shows autocorrelation, the Runs-test indicates greater variety, with less than half of all time-series returns being autocorrelated. As the non-parametric Runs-test is not subject to distributional assumptions, this suggests that part of the documented autocorrelation may be due to non-normality in the residuals. Additionally, the Durbin-Watson test does not distinguish between first and higher-order autocorrelation, i.e., different autoregressive processes. Consequently, the evidence may be indicating ARCH effects rather than 'simple' autocorrelation.[398] This issue will be further evaluated in subsection 4.4.1.5.

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statistical significance of the estimators will not be considered further. Conversely, this issue needs to be evaluated when assessing the interdependence of stock and index time-series.

[396] The Durbin-Watson d-test is based on the ratio of (squared) differences in successive period residuals to the individual (squared) residuals, with both being derived by regressing the focal variable on (an) explanatory factor(s). If successive period residuals are similar (positively autocorrelated), the test statistic will converge to zero, whereas it increases the more they differ in sign and/or magnitude (negative autocorrelation). Intermediate values (close to two) thus indicate the absence of either autocorrelation type.

In the present analysis, the time series were regressed on a constant to assess their inherent autocorrelation. Additionally, the Durbin-Watson statistics were calculated by regressing the 62 other time series on the Stoxx600. The results were highly similar.

[397] The Runs-test considers the sequence of either positive or negative residuals relative to a random process. Positive correlation between successive period residuals results in these 'runs' being long (and thus infrequent), as opposed to negative autocorrelation leading to frequent changes in the sign of residuals.

For an overview of the d- and Runs-test, see (Gujarati 2003), pp. 465-475. The tests are based on the pioneering work of (Durbin and Watson 1951) and (Geary 1970), respectively. Table 108 of the appendix provides the equations and full tables of test statistics.

[398] (Gujarati 2003) refers to d-test often indicating specification errors rather than data autocorrelation and suggests that "in time series regression, if a significant d value is obtained, we should test for the ARCH effect before accepting the d statistic at its face value." (p. 861).

Table 6: Results of Durbin-Watson and Runs Tests for Autocorrelation

Type of Time Series	No. of Time Series	Autocorrelation in Durbin-Watson Test*	Mean Durbin-Watson d-Statistic	Autocorrelation in Runs Test*
Stock Returns	46	46 (100%) 46 (100%) 46 (100%)	1.4307	20 (43.5%) 20 (43.5%) 23 (50.0%)
Index Returns	17	17 (100%) 17 (100%) 17 (100%)	1.5166	6 (35.3%) 6 (35.3%) 8 (47.1%)
All Series	63	63 (100%) 63 (100%) 63 (100%)	1.4538	26 (41.3%) 26 (41.3%) 31 (49.2%)

* From top to bottom, number of rejections shown at 1, 5, and 10% levels of significance

4.4.1.4 Stationarity Tests

If time series were non-stationary, the regression results would not be viable. More specifically, if the time series 'move' in time, any coefficients calculated would not hold for the entire time horizon studied or beyond (i.e., regression results would be 'spurious'). Stationarity requires that values be distributed homogeneously across time, i.e., mean, variance, and autocorrelation (or autocovariance) should be constant in (weakly) stationary data series.[399]

The present study employed the Augmented Dickey-Fuller test (ADF) statistic, the most commonly used measure of stationarity. The test assesses whether prior values significantly influence the change in observed values and is augmented by including lags of the dependent variable (i.e.,

[399] For time series to be strictly stationary, the entire distribution of values (i.e., including skewness and kurtosis) must remain constant, such that an observation drawn at random is equally representative of various sub-periods. For a general treatment of the concept of stationarity, cf. (Brooks 2002: 230-234; 367-376). Table 109 of the appendix discuss non-stationary proceses and show the conditions of both strict and weak stationarity.

past changes in realized values), which corrects for any dynamic structure in the dependent variable (e.g., autocorrelation).[400]

The ADF test was applied to all index return and stock return series. As demonstrated by Table 7, the tests reveal a consistently stationary nature of all return series.

Table 7: Results of Augmented Dickey-Fuller Test for Stationarity

Time Series	No. of Time Series	Non-Stationarity*	Mean Dickey-Fuller Z-Statistic	Mean Critical Value*/**
Stock Returns	46	0 (0%) 0 (0%) 0 (0%)	-30.3020 (6.7622)	-3.4322 -2.8612 -2.5702
Index Returns	17	0 (0%) 0 (0%) 0 (0%)	-40.0374 (2.9194)	-3.4300 -2.8600 -2.5700
All Series	63	0 (0%) 0 (0%) 0 (0%)	-32.9290 (7.3730)	-3.4316 -2.8609 -2.5701

* From top to bottom, number of rejections shown at 1, 5, and 10% levels of significance.

** Critical values differ slightly with the number of observations available

Note: Figures in Parentheses indicate standard deviation of test statistic across observations in (sub-)sample

Overall, the ADF test-statistic indicate a strong level of stationarity, as reflected in the average test-statistics exceeding the average critical values

[400] The ADF test regresses the differenced observations (as well as their lags) on the prior observation value. The test statistic simply is the standardized coefficient estimate for the differenced values. If there is no statistically significant relationship between the two, the data series is stationary. While insignificantly negative test statistics indicate mere nonstationarity, a significantly positive coefficient would suggest that non-stationarity compounds, leading to an explosive process.

by more than 2.5 standard deviations or about factor 10.[401] Consequently, the analyzed data series can be readily analyzed using standard time series methodologies.

4.4.1.5 Test for ARCH Properties

While basic heteroskedasticity generally is a concern in cross-sectional analyses (see subsections 4.5.1.2 and 5.3.3.1), the variance of time series data may systematically vary over time, resulting in autoregressive conditional heteroskedasticity (ARCH). As with non-normality and autocorrelation, ARCH does not impair the coefficient estimates themselves, but biases their standard deviations (i.e., significance tests) and the measures of model quality.

ARCH properties were tested for using the Lagrange Multiplier (LM) test proposed by (Engle 1982). This regression-based procedure can be applied to individual time series or fully specified regression models.[402] It assesses the constancy of variation in the time series or regression residuals across (two or several) subsequent time-periods. In the present study, the LM-test was applied to all stock and index return series, the standard market model regressing these time series on the STOXX 600 Index, and a model additionally including lagged terms of the dependent variable and of the market index (one lag each).

As demonstrated by Table 8, the individual data series are generally subject to ARCH. This indicates that there is substantial non-linear activity in the time-series data. The effect is stronger for shorter lags (in particular the lag 1 reported in Table 8), suggesting that extent of variation in the observations is time-dependent, however, without longer-term memory effects.[403] Similar dynamics appear to be present in the standard market model and (to a lesser extent) the double-lagged model.

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401 Table 110 presents the individual ADF test statistics for the stock and index time series.

402 In particular, two regressions are estimated: The variable under consideration is first regressed on a constant or on a set of explanatory variables. The squared residuals of this regression are then regressed on a constant and q lags of squared residuals. Finally, the test statistic is calculated as the R^2 statistic of the second regression multiplied by the number of observations.

403 As the LM statistic test the hypothesis that all lags are jointly insignificant (R^2 measure), including several lags increases the power of the test. In line with prior research, the present study used four lags. Results are only reported for lag 1, which clearly demonstrates ARCH effects. See Table 111 of the appendix for individual test scores.

Table 8: Results of Lagrange-Multiplier Test for ARCH Effects (Lag 1)

Time Series	No. of Time Series	ARCH in Individual Time Series	ARCH in Market Model	ARCH in Double-Lagged Model
Stock Returns	46	26 (56.5%) 30 (65.2%) 31(67.4%)	27 (58.7%) 30 (65.2%) 30(65.2%)	25 (54.3%) 28 (60.9%) 31(67.4%)
Index Returns	17 (16)	17 (100%) 17 (100%) 17 (100%)	15 (93.8%) 16 (100%) 16 (100%)	13 (81.3%) 14 (87.5%) 16 (100%)
All Series	63 (62)	43 (68.3%) 47 (74.6%) 48 (76.2%)	42 (67.7%) 46 (74.2%) 46 (74.2%)	38 (61.3%) 42 (67.7%) 47 (75.8%)

* From top to bottom, number of rejections shown at 1, 5, and 10% levels of significance.

4.4.2 Comparison of Alternative Return Generating Processes

4.4.2.1 Available Data and Prior Research

While the event-study method requires a proxy for general market influences on stock returns, various indices may serve this purpose. For the case of Europe, a variety of approaches have been taken.[404] While most European event studies rely on local (i.e., national) or general pan-European benchmarks, the present study differs slightly in that it encompasses companies from a variety of European countries within a clearly defined industry context.

In addition to general economic influences, the sample firms' stock returns may reflect country-, size- and/or industry-specific. Consequently, the present study has four different categories of indices to choose from:

(a) Broad market indices at the European or regional (e.g. Eurozone) levels capture general economic influences. In this regard, the present study uses the STOXX600, EuroSTOXX and STOXX-Non-Eurozone indices.

[404] See **Table 112** of the appendix for examples of prior event studies in the European context. Table 113 of the appendix conceptually distinguishes different types of specific return drivers and corresponding indices.

(b) Country-specific drivers of stock of stock returns are proxied by selective (Blue-Chip) indices for the country of focal firm origin.
(c) Size effects and the specific economic character of high-technology firms are reflected in 'new market' indices. The present study created an equally-weighted aggregate index based on the main three such indices (Techmark, Nexteconomy, and Nemax/Techdax).
(d) Industry indices may capture the biotechnology-specific drivers of stock returns. The present thesis distinguishes between generic pharmaceutical (STOXX Pharma/Biotech) and Biotechnology indices (StoxxBiotech) as well as a self-constructed European biotechnology index based on the industry definition derived in subsection 4.1.1.3.[405]

While general and broad industry indices are most commonly used in event-study research, the more focused indices or multi-factorial models merits some additional attention. To further analyze this issue, the explanatory power of different indices and combinations of indices will be empirically assessed.[406]

4.4.2.2 Time-Series Regression Models

In order to assess the validity of alternative return-generating processes, the present study employs a time-series regression approach. That is, regression models are specified using one (or several) index time-series as exogenous variables in explaining the time series of the focal firms' stock returns and measures-of-fit (i.e., explanatory power) are then compared across model specifications. This perspective is derived from prior research on stock-price synchronicity. For instance, (Morck et al. 2000) interpret synchronous movements of security prices and market indices as the extent of firm-specific information reflected. This notion goes back to

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[405] Both 'hightech' and 'biotech' indices are described as part of Table 107. As the latter approach is an intra-sample index, its validity in event-study analysis may be limited by an endogeneity bias. To account for this, the index was weighted equally, which reduces the extent of the bias to-1/46th . The author would like to thank Prof. Jankov Amihud, Ph.D., for providing valuable insights into this approach. All remaining shortcomings solely remain the author's responsibility.

[406] At the same time, different types of indices are highly correlated. As the data in Table 114 of the appendix suggests, there also are substantial differences in the extent of comovements between different index time series, although all correlations are highly significant statistically.

(Roll 1998), who first found low explanatory power of asset pricing regressions tied to high firm-specific volatility.[407]

Given the above evidence indicating ARCH effects, a time-series specification explicitly correcting for these disturbances is adopted. Specifically, a GARCH(1,1) model was employed correcting for both autoregressive and moving average processes in stock-return volatility. Since models including such (G)ARCH effects are estimated by the maximum likelihood estimation (MLE) method, the log-likelihood statistics represent an adequate goodness-of-fit measure.[408]

Since the log-likelihood statistics cannot be assumed to be normally distributed across all (46) company models, parametric difference of means tests (e.g., t-tests) may be biased. Consequently, this study uses (Wilcoxon 1945)-type paired rank tests.[409]

The proposed procedure was first implemented using different indices individually, then composing multi-factor models.

Results on Individual Indices

Table 9 provides the results of the Wilcoxon Paired-Rank tests on the log-likelihood statistics of the univariate model specifications. These models each included one index time series and the GARCH(1,1) effect.

The test results provide some insights into the explanatory power of different types of indices:

- The broad European index (STOXX 600) performs equally was as the model distinguishing Eurozone and Non-Eurozone countries, which suggests that regional differences are negligible compared. Similarly, national indices fail to prove superior compared to either European or

[407] While this interpretation has recently been challenged by (Ashbaugh-Skaife et al. 2005), its shortcomings mostly pertain the use of R^2 as an indirect measure of firm-specific information, whereas the present study applies it to directly measure the non-specific component of individual firms' return volatility.

[408] While not as easily accessible as the R^2 statistics in OLS-regressions, the log-likelihood is the entity being maximized in MLE estimation, similar to the sum of squared residuals in OLS regression. Complementarily, OLS-regression models accounting for standard heteroskedasticiy (White estimator, see 4.5.1.1) were also estimated and their explanatory power (adjusted R^2 measure) compared via non-parametric tests. The results are provided in Table 116 and Table 117 of the Appendix. Table 115 also shows the correlations between the different R^2 measures.

[409] This test is quite similar to the Wilcoxon-Sign-Rank-Test discussed in subsection 4.3.1.3. Instead of testing the occurrence of positive and negative values, however, it compares relative frequency of one series values exceeding anothers'.

regional models. This evidence is in line with (Bekaert et al. 2005), who observe increasinly stronger comovements (i.e., higher return correlations) among European stock markets.

- Industry-specific factors may be soundly approximated using a biotechnology index, which outperforms European and regional indices. Conversely, the generic STOXX Pharma/Biotech index appears inferior to all indices tested. This suggests that industry-specific influences may differ greatly for biotechnology and pharmaceutical segments.
- The self-assembled intra-sample index (of European DBFs) outperforms all other indices. While this may in part be due to the endogeneity bias discussed above, the it indicates that intra-sample congruence exceeds the impact of general industry-specific factors. This reinforces the notion that the firms identified by consensus analysis represent a rather distinct industry segment in terms of stock-market returns.[410]

Table 9: Significance of Wilcoxon Paired-Rank Test on Likelihood Statistics

Specification	**Stoxx 600**	**Euro-Zone**	**Local**	**StoxxPB**	**StoxxBT**	**Hightech**	**DBF-Index**
Mean	2393.6	2392.9	2394.6	2373.8	2409.6	2405.6	2429.3
Median	2133.0	2133.4	2140.4	2125.8	2140.8	2141.1	2187.0
Eurozone/Non	n.s.						
Local Indices	n.s.	n.s.					
StoxxPharma	---	---	---				
StoxxBiotech	n.s.	n.s.	n.s.	+++			
HighTech Index	+++	+++	+++	+++	n.s.		
DBF-Index	+++	+++	+++	+++	+++	+++	

+++/++/+ row index LL significantly larger than row index LL at 1%/5%/10% levels
---/--/- column index LL significantly larger than row index LL at 1%/5%/10% levels
n.s. no significant difference in LL of row and column index regressions

[410] Similar analyses were performed on a broader set of biotechnology stocks (results not reported here) and other alternative indices (e.g., Eurotops indices in lieu of Stoxx). These indicated that this effect persisted but its magnitude appeared smaller for larger samples, suggesting that the extensive sample selection procedure may have yielded a highly congruent sample.

Results on Combinations of Indices

Based on these results, the next step of analysis was to assess whether combining indices into multiple-factor models increases their explanatory power. Since the Eurozone and Pharma/Biotech indices were clearly dominated in the univariate models, they were dropped from consideration and the further analysis thus focuses the interaction of general, national, and industry indices. Table 10 exhibits the results for different multi-factor models.

The evidence from this set of tests highlights the importance of simultaneously considering different sources of stock-return variation:

- Models using combinations of indices generally outperform single-factor models. One notable exception is the fact that a two-factor model of general market (Stoxx600) and national indices fails to exceed the explanatory power of the Stoxx Biotechnology Total Market Index, which is a tribute to the importance of industry specific factors.
- The model combining national indices with the biotechnology-specific index (Stoxx Biotech) significantly increases explanatory power relative to models including either national indices and Stoxx 600 or Stoxx 600 and Stoxx Biotech. Consequently, the combination of country-specific and industry-specific volatility effects carries great weight in the composition of stock returns.
- Finally, a model containing general (Stoxx 600), national, and industry-specific variables (Stoxx Biotech) surpasses the explanatory power of all other univariate of multi-factor models. However, this effect becomes insignificant in the OLS specification (adjusted R^2 measure).[411] This suggests that the benefits of combining both general and nation indices with the industry-specific one may be limited and reinforces the validity of the more parsimonious model.

In summary, the time-series analysis suggests that country- and industry- as well as industry-segment-specific influences may better explain DBF stock returns than the broader indices generally used in prior event-study research. Therefore, the present study employs alternative return-generating processes to control for such deviations. The standard market model building on the Stoxx 600 index is complemented by a two-factor model incorporating country-specific and general industry effects (Stoxx

[411] More generally, using the log-likelihood statistics, while methodologically warranted, has one main drawback. As an absolute measure of explanatory power, it does not penalize models for using greater numbers of variables (i.e., reducing degrees of freedom). Ceters paribus, the inclusion of additional variables will thus lead to an increase in the log-likelihood statistic.

Biotech) as well as a market-adjustment procedure using the self-constructed intra-sample index.[412]

Table 10: Significance of Wilcoxon Paired-Rank Tests on Likelihood Statistics

Indices	Mean	Median	Stoxx600 / Local	Stoxx600 / Stoxx Biotech	Local/ Stoxx-Biotech	Stoxx600 / Local/ Biotech
Stoxx600	2393.61	2132.99	+++	+++	+++	+++
Local Indices	2394.59	2140.35	+++	+++	+++	+++
Stoxx Biotech	2409.62	2140.84	n.s.	+++	+++	+++
Stoxx600/ Local	2386.47	2140.72				
Stoxx600/ StoxxBT	2405.58	2141.65	+++			
Local/ Stoxx BT	2408.86	2146.37	+++	+++		
Stoxx600/ Local/BT	2411.10	2147.80	+++	+++	(+++)	

+++/++/+ Column index LL significantly larger than row index LL at 1%/5%/10% levels
---/--/- Row index LL significantly larger than column index LL at 1%/5%/10% levels

4.5 Cross-Sectional and Panel-Data Approaches

Once ARs have been derived and tested using the methods outlined in subchapter 4.3, the determinants of variation in these ARs may be studied using cross-sectional methods. This subchapter provides an overview of the procedures used in the present study: Standard regression analysis and regression diagnostics as well as the more advanced panel-data and selectivity models.

412 As noted in subsection 4.3.1.3, the market-adjusted returns method is used to reduce the potential impact of individual sample firms, who may also figure prominently into the self-constructed index.

4.5.1 Regression Analysis

4.5.1.1 Standard OLS Regression Analysis

Within the scope of the present work, ordinary least squares (OLS) regression analysis is used in three different contexts. First, it was applied as an alternative to the time-series GARCH specification in section 4.4.2. Second, it is fundamental to both the (univariate) market model as well as the multi-factor model used to calculate the expected returns in the event-study analysis (also see subsection 4.3.1.1). Third, it is the most common technique for cross-sectional analysis of the abnormal returns derived by the event-study method.[413]

Given the standard use of OLS estimation, the method is not extensively treated here. In brief, it defines the relationships between the dependent and independent variables as an additive, linear function minimizing the sum of squared residuals, i.e., deviations from the observed data.[414]

Under specific assumptions, this approach yields estimates that are unbiased and efficient, i.e., best linear unbiased estimators (BLUE). Most textbooks and methodology texts provide lists of regression assumptions [e.g., (Berry 1993), (Gujarati 2003)].[415] As their violation may invalidate the results of the OLS analysis, they are commonly tested in empirical research. .

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413 Table 75 of the appendix include information on the cross-sectional methods used in prior event studies. Some authors also use one-way analysis of variance (ANOVA) to test for statistical differences between subsamples. These include (Anand and Khanna 2000), (Reuer 2000), (Hanvanich et al. 2003), and (Sleuwaegen et al. 2003). (Anand and Khanna 2000) later resort to multiple regression for detailed analysis.

414 See Equations (32) and (33) of the appendix for the standard OLS setup and parameter specifications. Mathematically, the estimation parameters α and β are analytically derived by solving a set of equations using standard calculus. Along the way, the method accounts for the interdependence among explanatory variables by constructing auxiliary regressions of each independent variable on all others. For a general treatment of the OLS fundamentals, see (Lewis-Beck 1980), (Achen 1982), and (Schroeder et al. 1986).

415 Table 118 of the appendix compares two such laundry lists of definitions of model. Note that some of these assumptions are only required for the methodology to yield uniquely defined parameter estimates. The present section, however, focuses on those pertaining to the quality of estimation, rather than its mere feasibility.

4.5.1.2 Regression Diagnostics

For practical purposes, the error terms of regression models may be examined to detect deviations from the assumptions that would compromise the analysis. In particular, these relate to the heteroskedasticity, autocorrelation, normality, and independence of error terms.

- Heteroskedasticity reflects inconstant error variance, which in turn may compromise the validity of significance tests and goodness-of-fit indicators. Specifically, the variance of residuals may vary with (expected) values of the dependent variable and/or with individual explanatory variables. While the parameter estimates themselves remain consistent and unbiased in the presence of heteroskedasticity, any statistical inference (i.e., with regard to the statistical significance of individual parameters of goodness-of-fit measures overall) will be biased. Since it is the objective of this study to uphold or reject certain hypothesized effects, heteroskedasticity is a substantial concern.

  Two approaches were used to identify heteroskedasticity: On one hand, graphical inspection of scatter plots matching (standardized) residuals with dependent and independent variables may show inconstant variation in the residuals. On the other hand, tests proposed by (Breusch and Pagan 1979) and (Szroeter 1978) provide formal assessments of the extent and sources of heteroskedasticity.

  In the presence of non-constant error variance, the present study used the heteroskedasticity-consistent estimators proposed by (White 1980), which generically account for variation in error dispersion.[416] Comparable event-study research using White-estimators to correct for heteroskedasticity in the cross-sectional analysis includes (Balakrishnan and Koza 1993), (Park and Kim 1997), and (Yao and Ge 2002).
- Autocorrelation is mostly limited to time-series analyses. In the present research, it may also be a concern in the cross-sectional analysis, since many firms announce several alliances. The Durbin-Watson d-test statistic used in the time-series analyses (see subsection 4.4.1.3) thus may also be applied to the cross-sectional data. Similarly, (Park and Mezias 2005) use it to explicitly test for autocorrelation between multiple observations (i.e., alliance formation announcements) per focal firm.

[416] That is, White-estimators do not require explicitly specified error variances. Provided the source of heteroskedasticity were known, an alternative approach would be using the variable-specific variability to construct Generalized Least Squares (GLS) models. Also see Equation (34) in the appendix for White's heteroskedasticity-consistent estimators.

- Normally distributed residuals, while not a necessary condition for arriving at BLUE estimators, is an assumption underlying the use of the normal distribution in assessing their statistical significance. Yet, as (Berry 1993) notes, "statisticians have shown, relying on the central limit theorem, that when estimation is based on a large sample, the sampling distributions of regression coefficient estimators are normally distributed even when the equation's error term is not." (p. 82). Consequently, normality usually has not been tested for in the alliance event-study literature. As outlined in subsection 4.4.1.1, the present study applied graphical and formal normality tests in the time series analysis.[417]
- The assumption of independent error terms may be affected by various aspects. In addition to multiple events occurring on the same day (subsection 4.3.3.1), multiple observations may related to same event (i.e., collaboration between multiple focal firms). Some studies aggregate these into super-observations reflecting the average AR to participating firms to maintain the assumption of cross-sectional independence.[418] However, the majority of prior research treat all observation as separate events [e.g., (Anand and Khanna 2000), (Kale et al. 2002)]. As the share of intra-sample transactions in the present study is relatively small (26/328) and super-observations would prevent the use of firm-specific variables (e.g., the direction of resource transfers, payments etc.), aggregating intra-sample transactions could be more harmful than beneficial.[419]

Additional diagnostic attention is warranted for factors potentially influencing the validity of estimation results, while not outright violating regression assumptions. In the present context, outliers and high (but imperfect) multicollinearity fall into this category:

- Outliers are observations that differ substantially from the general logic of the overall sample. Due to this discrepancy, they may unduly affect

[417] While non-normality was detected in both stock and index return time series, this does not interfere with the event study procedure using this data. Specifically, non-normality invalidates the standard errors of coefficient estimates and thus their statistical significance. However, the point estimates of the coefficients remain unbiased and the event study method only relies on these point estimates.

[418] Specficially, (McConnell and Nantell 1985) and (Gulati and Wang 2001), weigh the participating firms' returns equally, whereas (Chan et al. 1997) use value-weighted return portfolios.

[419] Another type of interdependence between observations arises from multiple events relating to the same focal firm. This aspect is pursued in greater detail in the follwing section on the use of panel-data methods.

the estimation results, reducing the validity of inference. Methodologists distinguish the mere divergence of certain observations from their influence on the estimation results [e.g., (Fox 1991)]. On one hand, large (standardized) residuals indicate that observations were not predicted by the overall model. On the other hand, the distance measure proposed by (Cook 1977) also accounts for the impact each individual observation has on the estimation results. In the present study, observations having a standardized residual greater than three in absolute terms or a Cook's Distance value of over one were considered as outliers [following (Achen 1982)] and were subjected to an individual review.[420]

- Similarly, high correlation among the explanatory variables, while not violating the assumption of imperfect multicollinearity, may lead to instability in the parameter estimates [cf. (Fox 1991)]. While the correlations among independent variables were considered prior to constructing cross-sectional regression models (see sections 5.2.1 to 5.2.3), an ex post control for such effects may be warranted. The collinearity of all variable was assessed based on variance-inflation factors (VIFs). A high VIF indicates that the given variable is linearly related to the set of concurrently used ones, which may substantially reduce the precision of its parameter estimate.[421]

4.5.2 Firm-Specific Effects and Panel-Data Methods

While the preceding subsection addressed statistical assumptions applicable to all OLS regressions, the present sample represents a specific data structure, drawing several observations from each focal firm. This can lead to violation of the independence assumption, which would may show as heteroskedasticity and autocorrelation in the regression residuals. (Anand and Khanna 2000b), (Kale et al. 2002), (Park et al. 2004), and (Park and

[420] The cut-off value for Cook's Distance proposed by (Fox 1991) is 4/(n-k-1), i.e., 4 devided by the residual degrees of freedom for the given estimation model (p. 34). In the present context, however, it would result in a great number of observations (~10%) being classified as outliers. Similarly, using cut-offs at +/–2 for standardized residuals would identify about 6% of all observations as outliers.

[421] Technically, the VIF incorporates the explanatory power of the auxiliary regressions explaining the given as a linear function of all other independent variables. Since it is defined as 1 over 1 minus the R^2 statistic of the respective auxiliary regression, it converges to infinity for highly collinear variables, reflecting that in cases of perfect collinearity the variable coefficients are no longer uniquely identified.

Mezias 2005) provide evidence for such firm-level heterogeneity in ARs, i.e., that certain firms experience consistently higher returns upon entering into collaborative agreements.[422]

4.5.2.1 Alternative Panel-Data Models

Panel-data methodology distinguishes two main types of specifications: Fixed and random effects models.

First, fixed-effect models assume that the dependent variable systematically varies between units of study, i.e., unobserved heterogeneity is constant at the unit level. Equation (16) shows the general set-up for such models. That is, only the deviations from the firm-specific intercepts [α_i in Equation (16)] is explained by the other independent variables.[423] The coefficient estimates are thereby corrected for the inter-unit effects, leaving only the observation-specific (intra-unit) effects. Obviously, this approach is very costly in terms of the degrees of freedom lost, since each unit requires an additional (dummy) variable. Additionally, as (Green 2000) points out, the shifts of the regression function reflected by unit-specific effects may not be generalized to observations outside the study sample.[424]

422 (Schlingemann et al. 2002). use a similar approach in their study of firms conducting multiple M&A transactions. Furthermore, (Green 2000) provides an overview of potential applications in the social sciences (pp. 557-560). In addition to unit-specific effects, variance may differ along the time dimension (i.e., the x^{th} observation from each unit being non-independent). See Table 119 in the appendix for a discussion, why this issue was not pursued further and Table 120 for a conceptual framework of the model-selection approach.

423 Practically, a dummy variable is inserted for each firm to reflect these fixed effects, which is why such specifications are also referred to as least squared dummy variables (LSDV) models. As the firm-specific effects thus form part of the overall set of independent variables used, their interdependence with other explanatory factors is implicitly corrected for through the standard auxiliary regressions. Also see FN 414.

424 This shortcoming may only be troublesome, if the research interest lies in explaining the absolute value of the dependent variable, e.g., for prediction purposes. The parameter estimates and significance tests on the other explanatory variables are unaffected by this argument. Similarly, the firm-specific fixed effects only are consistent for panels, in which $T \rightarrow \infty$ (i.e., the number of time-series observations per unit converges to infinity), whereas the other parameter estimates are consistent regardless [cf. (Green 2000), pp. 575-6].

$$y_{i,t} = \alpha_i + \sum_{v=1}^{V} \beta_v x_{i,t} + \varepsilon_{i,t} \tag{16}$$

with:

$y_{i,t}$ = Dependent variable

α_i = Unit-specific regression intercept (fixed effect)

β_v = Estimated coefficient for variable v

$x_{i,t}$ = Observations on independent variable v

$\varepsilon_{i,t}$ = Estimation error

Second, random effects models treat unit heterogeneity as randomly drawn from a continuous distribution of firm effects. (17) presents the general model. Essentially, the parameter estimates are only corrected for the non-random variance component. That is, the correction depends on the relative extent of systematic inter-unit [u_i in Equation (17)] and inter-observation variance ε_{it} in Equation (17)].[425] This makes them less restrictive with regard to out-of-sample generalization and imposes less of a burden on the degrees of freedom. However, it renders them more cumbersome to estimate in practice. OLS assumption no longer hold due to the hypothesized heterogeneity at the unit level, necessitating the use (feasible) generalized least squares, (F)GLS.[426]

$$y_{i,t} = \alpha + \sum_{v=1}^{V} \beta_v x_{i,t} + u_i + \varepsilon_{i,t} \tag{17}$$

with:

$y_{i,t}$ = Dependent variable

α = Regression intercept

β_v = Estimated coefficient for variable v

$x_{i,t}$ = Observations on independent variable v

u_i = Unit-specific error vector (i.e., normally distributed variation in α for unit i)

$\varepsilon_{i,t}$ = Estimation error

425 That is, the model converges to OLS if u_i approaches zero, whereas it is similar to the LSDV approach if u_i is non-random [then: $\alpha_i = \alpha + u_i$].

426 Alternatively, random-effects models may be estimated using maximum-likelihood methods. For further details on such technical aspects of panel-data models, cf. (Green 2000)

In prior alliance event studies, (Anand and Khanna 2000) and (Kale et al. 2002) apply one-way (company) fixed effects models, whereas (Park and Martin 2001), (Park et al. 2004), and (Park and Mezias 2005) use random effects.

4.5.2.2 Testing Procedures for Panel Effects

The present research explicitly tests for the appropriateness using panel-data methods. For this purpose, it employs a two-stage approach:

First, the existence and relevance of firm-specific effects may be demonstrated by showing that the panel specification significantly improves model fit or that error terms are clustered for individual units of observation.

- Standard F-Ratio tests reflect the significance of firm-level heterogeneity in fixed effects models. This explicitly tests the validity of restricting the model (i.e., excluding the firm fixed effects) based on the difference in explanatory power (R^2 measures) relative to the degrees of freedom gained.[427] This test thus provides evidence regarding the existence of firm-specific effects in the overall data.
- (Breusch and Pagan 1979) propose a Lagrange-Multiplier test for firm-level heterogeneity in the error terms of OLS regressions. This test is based on consistent signs of individual firms' residuals and on their magnitude relative to overall residual variance.[428] While it is mostly considered as a test for random effects [e.g., (Green 2000), pp. 572-3], it also generally indicates the existence of firm-specific variation.

Second, the relative validity of either specification may be tested. As observed by (Judge et al. 1985), the estimates derived via fixed and random effects models may differ substantially, in particular in large N (number of firms), small T (number of observations) samples, such as the present one. Furthermore, random effects specifications may not only be less stressful on the degrees of freedom, but also more efficient under such conditions [cf. (Taylor 1980)]. As long as the random-effects assumptions hold, it should thus be preferred for the present setting:

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[427] For general treatments of the F-Test and its application to fixed-effects models, see (Green 2000)[pp. 561-566] and (Gujarati 2003) [pp. 254-9, 643].

[428] Note that this is functionally equivalent to testing for (serial) correlation among the residuals of sample firms. See (Wooldridge 2002) [p. 264-5] for an overview of alternative tests employable with regard to serial correlation in the residuals that may reflect unobserved heterogeneity among units of observation.

- The (Hausman 1978) specification test provides a tool to validate the RE assumption that the unobserved heterogeneity is independent from the explanatory variables. It assesses the extent to which the coefficient estimates of fixed and random-effect specifications vary. A statistically significant difference implies that the unobserved effects would be systematically related to some (or all) covariates, if they were not restricted to unity (i.e., being fixed for each firm). This non-independence of the unobserved effects renders random effects inconsistent and requires the use of fixed effects.[429]

All three tests [F, (Breusch and Pagan 1979), and (Hausman 1978)] were employed to address the adequacy of (a) correcting for firm-specific effects and (b) using either random or fixed-effects models.

4.5.3 (Self-)Selection Effects in the Formation of Strategic Alliances

As many hypothesized influences may determine alliance formation as well as performance, their value impact be direct of mediated by likelihood of alliance formation (Hypothesis 13).[430] (Arend and Amit 2005) suggest that controlling for (self-)selection effects may be warranted. Yet, their analysis only pertains to the overall value generated by focal firms, not the value impact of specific transactions. Similarly, studies by (Stuart et al. 1999), (Gulati and Higgins 2003), and (Janney and Folta 2003) have ex-

[429] As random-effects models are generally estimated using GLS, they even require a specific structure of the error matrix, which is not considered in the Hausman test, but can be circumvented by using MLE. All other assumptions, such as exogeneity, are consistent for both approaches, but also need to be met for the test to yield viable results. For a more detailed discussion of model assumptions and testing approaches, cf. (Wooldridge 2002) [pp. 251-9, 288-91].

[430] Additionally, the market's anticipation of an event may also affect its reaction. As pointed out in subsection 4.3.3.1, the observed stock returns following a news announcement are conditioned upon market expectations, which may lead 'likely' transactions to experience reduced AR. Consequently, controlling for (self-)selection in the sample composition also accounts for these anticipation effects.
In this context, (MacKinlay 1997) discusses the nature of self-selection effects with regard to event studies and explicitly refers to selection bias. While (Prabhala 1997) shows that standard event-study methodologies may competently deal with rational expectations of event announcements, this only extends to the event study itself, but not potential distortions in the cross-sectional analysis of ARs.

plicitly considered selection biases in the occurrence of more general corporate events, in particular IPOs.[431]

Conversely, even the latest event-study research into corporate alliances has stopped at using fixed- or random-effects models to account for interfirm variation.[432] While (self-)selection may be of limited importance in samples with homogeneous alliance activity (i.e., similar numbers of alliances per firm), individual firms account for between 1 and 30 events in the present sample (0 and 27 after correcting for confounding news). Therefore, the present study attempts to more fully explore the influence of self-selection effects, i.e., whether firm characteristics affect alliance formation, which in return affects value-creation. Additionally, it extends this approach to environmental conditions, which may also simultaneously affect alliance formation and the observed announcement returns.

General Econometric Modeling of Selection Biases

The standard approach for considering (self-)selection goes back to (Heckman 1979). It first estimates the likelihood of an event occurring based on a set of explanatory variables. More specifically, the likelihood of each observation being excluded from the sample is derived, which is then used as a correction term in the main regression.[433] The original Heckman approach focused on binary cases, i.e., observations being included in or excluded from the sample, which can be estimated using standard probit or logit models.

(Lee 1983) provides generalized selection modeling approach based on the same principles, which is shown in (18). The correction term {…} ac-

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[431] (Hand 2004) also discusses the potential selection bias arising from studying only firms, who successfully perform an IPO, but chooses not to explicitly correct for it. In related work, (Kale et al. 2002) analyze the establishment of an alliance management function, which serves as an independent variable in explaining AR on alliance formation.

[432] Fixed and random effects models greatly reduce the potential biases arising from unobserved heterogeneity. In the most extreme case, fixed-effects models reduce the influence of unit-level variation in the dependent variable to zero. At the same time, this approach does not account for the actual sources of such biases. In particular, firm-level heterogeneity may be reflect variation in the importance of collaborative activity or in the access to high-quality collaborators. In this case, firm-specific effects may do the trick, but information will be lost by the rather crude approach.

[433] (Winship and Mare 1992) provide a broader review of sample-selection models, including a critique of the Heckman approach and alternative, mostly semi- or non-parametric models. (Wiggins 1999, 2005) discusses practical aspects of estimating the non-selection hazard.

counts for the risk of an observation being excluded from the sample, similar to the Inverse Mills Ratio in bivariate Heckman-models. Specifically, it takes the value of the standardized hazard density function over the standardized hazard function, reflecting the probability that a unit switches categories at a given point in time.

$$Y = X\beta - (\sigma\rho)\left\{\phi\frac{\left[\Phi^{-1}F\ (z_i\gamma)\right]}{F\ (z_i\gamma)}\right\} + \eta \tag{18}$$

with

Y	=	Dependent Variable Matrix (as in standard OLS)
X	=	Independent Variable Matrix (as in standard OLS)
ß	=	Estimated Coefficient Vector (as in standard OLS)
σρ	=	Estimated Coefficient Scalar on Selection Variables
ϕ	=	Standard normal density function
Φ	=	Standard normal distribution function
F(z γ)	=	Hazard Function based on covariates z_i and base hazard γ
η	=	Error Term [E(η| I=1, x, z)=0]

The generalized model for sample selection works with a variety of approaches for deriving the conditional probability of an observation being excluded from the sample.[434]

Specific Approach of the Present Thesis

In their study of IPO returns, (Stuart et al. 1999) employ the general selection approach in conjunction with a hazard (or survival) model of the time to IPO. Following this precedent has two main advantages: First, it makes best use of the information by modeling the exact time between alliance announcements. All alternatives would either aggregate all observations into an alliance count (e.g., for Poisson or negative binomial models) or require constructing artificial time intervals, such as binary choice (logit or

434 The main drawback of this approach is that it may require a quite cumbersome modification of the error terms. As (Wooldridge 2002) puts it bluntly, “it is *not* enough to simply make the standard errors heteroskedasticity-robust” (p. 564). However, this adjustment is not required, unless (self-)selection effects turn out to be significant. As observed in subsection 5.4.2.2, the estimated coefficient (σρ) on the selection variable does not gain significance in any model. Therefore, standard heteroskedasticity-consistent estimators could be used.

probit) models of alliance formation on a monthly or quarterly basis. Second, it allows to include both time-varying firm-specific and environmental explanatory variables. Alternatively using a count model would have restricted the analysis to time invariant firm-level covariates.[435]

The present study estimated several (Cox 1972) proportional hazard models, explaining the time periods (in days) between alliance formation announcements. As illustrated in (19), these allow to predict the likelihood (or hazard) for a given firm to form an alliance at any given point in time.[436] More specifically, λ (t,X) represents the probability or rate of a unit (i.e., firm) leaving the initial state (of no new alliance formed) per unit of time [e.g., (Wooldridge 2002), pp. 686-7]. As using the exact same variables in the selection and main regressions may lead to spurious estimation [e.g., (Arend 2005)], the model includes a number of covariates expected to influence the rate of alliance formation without being control or hypothesized effects for collaborative value creation.[437]
The estimated hazard λ (t,X) for each event is used to construct a control variable [i.e., {…} in Equation (19)] which is then included in the main regression.

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435 The author would like to thank Professor Toby E. Stuart of Columbia Business School for discussing the subtleties of this approach.

436 To incorporate the greatest amount of available information, the dataset for the sample-selection function was constructed to reflect the potentially daily occurrence of new alliances. That is, each day a focal firm was publicly listed during the 1997-2003 period constituted one observation, with covariates being updated as they become available (i.e., accounting data being constant for a calender year, market activity for a month, stock-market data being updated daily). This approach is similar to (Stuart et al. 1999) modeling the 'IPO hazard' on a monthly basis and takes into account that 23.86% (47.27%) of all formation announcements occurred within 30 (90) days from the previous one. An alternative approach is discussed in Table 121 of the appendix, but does not yield substantively different results (see Table 170).

437 While survival-analyses, generally assume that each observation is independent, multiple observations refer to each sample firm in the present study. Additionally, the occurrence has a natural order in time. Both of these issues may affect model estimation and were accounted for using the appropriate tools [cf. (Therneau and Gramsch 2000) for the specifics of running Cox models with multiple observations per unit of study].

$$\log \lambda(t, X) = \log_0(t) + X\beta \tag{19}$$

with:

$$\lambda[t, X] = \lim_{h \to 0} \frac{P\,[t \leq T \leq t + h \mid T > t, X]}{h}$$

and

$Log_0(t)$	= Base Hazard
Xß	= Matrix of Explanatory Variables and Vector of Corresponding Coefficients
T	= Survival Time (i.e., time since last event)

4.6 Summary

The present section has pursued three goals. First, it has presented the sample selection and coding procedures applied as well as the sample of alliance-related events to be analyzed in the following section. Second, it has provided an overview of the broad range of methodologies available to event-study researchers (including the cross-sectional analysis of abnormal returns) and has discussed their relevance to the present work. Third, it has analyzed the time-series data of security and index returns and provided insight into the value of applying alternative return models in the event-study procedure.

What remains to be done is to summarize the choice of methods to be applied in the following section, which will then focus on the results rather than the mechanics of these analyses. Table 11 provides such an overview with regard to the methodologies applied in the empirical analysis.[438] The corresponding results are discussed in the following chapter.

[438] Furthermore, some potential sources of biased or false inference were addressed during the sample selection, data coding, and data management stages. Table 122 of the appendix summarizes these issues, which are not further addressed in chapter 5.

Table 11: Overview of Methodologies Applied in Present Study

Stage	Concerns	Methodology
Event Study		
AR Estimation	Parsimonious estimation mode - context-specific return drivers - smoothing endogeneity effects	Market model 2-Factor-Model Market Adjustment
	Standard benchmark - context-specific return drivers - sample-specific return drivers	Stoxx 600 National Indices/Stoxx Biotech Self-constructed DBF/intra-sample Index
		200-day Estimation Period 12 different Event Windows
Significance Testing	Powerful overall Test - robust to interdependence - robust to variance increases	Dodd-Warner Test Brown-Warner Test Cross-sectionally-standardized Test
	- robust to non-normality	Corrado Test
Cross-Sectional Analysis		
Standard OLS	Assurance of Homoskedasticity	Breusch-Pagan Test ⇔ White Heteroskedasticity-Consistent Estimators
	Assurance of Non-Autocorrelation	Durbin-Watson d-Test
	Assurance of Normality	Shapiro-Wilks Test Skewness/Kurtosis Tests
	Assurance of Independence	- [corrected in Heckman-/Lee-type model]
	Outliers	Standardized Residuals Cook's Distance
	Multi-Collinearity	Variance-Inflation Factors (VIF)
Advanced Methods	Firm-specific Effects	F-Test / Breusch-Pagan Test / Hausman Test Fixed-/Random-Effects models
	Self-Selection Effects	Heckman-/Lee-type Selection Correction Model

Source: Own Compilation

5 Results of Empirical Investigation

"In nature's infinite book of secrecy
A little I can read"

William Shakespeare: Anthony and Cleopatra (I.2.10-11)

This chapter summarizes the findings based on the methodological approaches outlined in the preceding chapter. In particular, these analyses encompasses two main components: First, it empirically analyzed the value impact of alliance-related announcements using the event-study method (5.1). Second, it examined the cross-sectional influences on alliance formation ARs. In addition to the main multivariate regression models (5.3), this entailed a brief review of univariate correlations between and various explanatory factors (5.2) as well as extensions accounting for firm-specific and self-selection effects (5.4).

5.1 Announcement Effects of Alliance-Related Announcements

5.1.1 Daily and Cumulative Abnormal Returns on Entire Sample

The present study first calculated the ARs for each day of the observation period ranging from 10 days prior to the announcement to 10 days after the announcement. Figure 36 exhibits the aggregate ARs for all three return models specified in subsection 4.4.2.1: The standard market model (Stoxx 600), a two-factor model (national indices/Stoxx Biotech), and market adjustment using the self-constructed intra-sample index of European DBFs.[439]

[439] While the explanatory power of the three models deviates in time series models (see subsection 4.4.2.2 as well as Table 123 of the appendix), the calculated ARs are highly similar. In particular, the correlation coefficients of ARs

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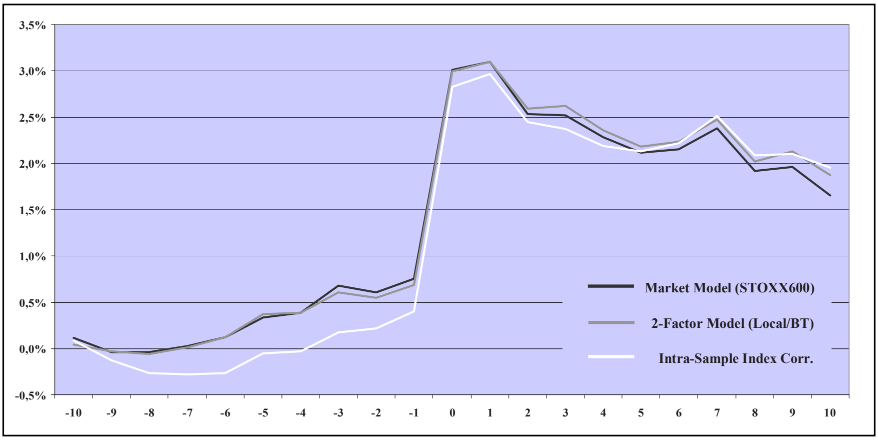
On an aggregate level, these findings support the notion of alliance-related news having a substantially positive impact on firm value. The main effect occurs on the event day itself, indicating that the market recognizes the announcements as new information. In addition, there appears to be some activity before and after the actual announcement date:

- Some information may already be incorporated during the days leading up to the announcement, but such anticipatory effects appear limited.
- While the day +1 returns may still be positively affected by the announcement, firms loose between 1% and 1.5% during the ensuing period. However, the net effect of the announcements over the entire 21-day period remain positive, in the range of 1.5% to 2%.

Figure 36: Summed Daily AAR over Event Period



Data Source: Own Analysis

The statistical significance of the daily ARs was analyzed using the four different test statistics presented in subsection 4.3.1.2: Parametric Dodd-Warner, Brown-Warner, and Cross-sectionally-standardized tests as well as the non-parametric Corrado rank test. As presented in **Table 12**(a) and (b), the main findings are consistent across return models and test statistics:

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across models for the same event window effectively approach the value one (see Table 124 of the appendix).

Note that the summed AAR exhibited in Figure 36 differ from the CARs referred to in section 4.3.1 and analyzed further in the present chapter. Specifically, the daily AR shown in **Table 12** and forming the basis of Figure 36 only were corrected for confounding events on the announcement date itself. Contrarily, CARs are only calculated based on events without any confounding items during the entire period.

- The ARs on the day of the announcement itself are significantly positive. Their magnitude ranges 2.26% (STOXX600 market model) to 2.42% (intra-sample model) reflecting a substantive effect of alliance-related news items. Firms on average also experience positive ARs during the two days surrounding the announcement (days –1 and +1), but these returns remain far from statistically significant. Similarly, ARs for day –3 are positive, but only significant for some tests.
- The ARs 2 and 8 days after the announcement are significantly negative. However, their magnitude remains small compared to the initial announcement returns. For all three models, they are in the range of 0.5% each. Other ARs following the announcement also tend to be negative.[440] This reinforces the observation that some of the value created by alliance-related events dissolves during the post-event period. This negative AR trend following the announcement may be attributed to market overreaction or Investors cashing-in on the announcement gains and is not uncommon in event-study research.[441]

Overall, the statistical evidence is highly congruent across return models and testing procedures, which reflects the great robustness of these results. However, some findings diverge and may require additional explanation, although they do not appear to be systematic:

- While the market-adjusted return model (employing the self-constructed intra-sample index of European DBFs) appears to be quite powerful (e.g., no significance for days –/+3, +5, or +10 in any test), it exhibits significantly positive ARs for day +7 in all three parametric tests, which are also positive but generally insignificant using the two other return models. As this effect becomes insignificant using the Corrado rank test, it may be due to a small number of events with exceptionally high returns on this day. In almost all other respects, the three return-generating processes demonstrate highly similar results.[442]
- Among the different significance tests, the Dodd-Warner statistic appears to be most sensitive to variation in ARs (e.g., significant tests for days +5 and +10 in both market and 2-factor models). While the Brown-

440 Overall, 6 of the 9 days in the range of +2 to +10 exhibit negative ARs. Contrarily, only 3 of the 9 days in the respective range preceding the announcement (–10 to –2) did. The ARs differ slightly among return models.

441 Similar patterns have also been observed in the ARs to M&A announcements [e.g., (Bae et al. 2002)]

442 A correlation analysis of ARs shows extreme congruence with correlation coefficients ranging from 0.9844 (2-Factor model/Market adjustment) to 0.9955 (Market model/2-Factor model). Consequently, all differences between returns models small substantively.

Warner and cross-sectionally standardized test rely on cross-sectional measures of variation, the Dodd-Warner-statistic is driven primarily by the individual security's variance during the estimation period.[443] Consequently, the deviating findings on particular days may reflect low-variation firms experiencing overproportionally low (i.e., negative) abnormal returns on these days. This rationale may be particularly relevant for day +5, where both other tests fail to indicate significance by a wide margin and unstandardized AARs are relatively low (between 0.06% and 0.17% depending on the return model).

[443] See section 4.3.1 for details.

Table 12: Results of Event Study by Day over Event Period (All Alliance-Related Events)

Window	N	Market Model (Stoxx600)					2-Factor-Model (Local/StoxxBiotech)					Market Model (Intra-Sample Index)				
		CAAR	Z (DW)	Z (BW)	Z (CS)	Z (Corr)	CAAR	Z (DW)	Z (BW)	Z (CS)	Z (Corr)	CAAR	Z (DW)	Z (BW)	Z (CS)	Z (Corr)
-10 to +10	277	0.0067	0.37	0.76	-0.58	0.51	0.0099	0.82	1.18	-0.35	0.66	0.0128	1.15	1.54	-0.26	0.77
-10 to +3	398	0.0261	2.78 ***	3.62 ***	1.68 *	2.11 **	0.0283	3.15 ***	4.12 ***	1.89 *	2.17 **	0.0268	2.92 ***	3.86 ***	1.61	1.66 *
-10 to +1	427	0.0316	4.26 ***	4.74 ***	2.61 ***	2.71 ***	0.0322	4.39 ***	5.07 ***	2.64 ***	2.66 ***	0.0312	4.11 ***	4.95 ***	2.43 **	2.16 **
-1 to +10	417	0.0066	0,89	0.99	0,33	0.36	0.0098	1,31	1.55	0,68	0.74	0.0157	1,76 *	2.38 **	1,52	1.48
-5 to +5	428	0.0237	3.12 ***	3.72 ***	1.56	2.29 **	0.0250	3.36 ***	4.12 ***	1.69 *	2.26 **	0.0295	3.99 ***	4.79 ***	2.19 **	2.70 ***
-3 to +3	500	0.0254	4.73 ***	4.99 ***	2.39 **	3.24 ***	0.0273	5.19 ***	5.63 ***	2.71 ***	3.30 ***	0.0284	5.46 ***	5.77 ***	2.72 ***	3.44 ***
-2 to +2	524	0.0238	5.16 ***	5.52 ***	2.31 **	2.71 ***	0.0252	5.64 ***	6.15 ***	2.58 **	2.95 ***	0.0282	6.43 ***	6.80 ***	3.12 ***	3.50 ***
-3 to +1	532	0.0320	7.70 ***	7.43 ***	4.37 ***	4.51 ***	0.0321	7.78 ***	7.82 ***	4.37 ***	4.39 ***	0.0345	8.33 ***	8.31 ***	4.74 ***	4.64 ***
-2 to +1	547	0.0280	7.40 ***	6.50 ***	3.85 ***	3.97 ***	0.0286	7.64 ***	6.96 ***	3.95 ***	4.08 ***	0.0312	8.32 ***	7.52 ***	4.50 ***	4.51 ***
-1 to +1	564	0.0285	9.30 ***	8.54 ***	4.71 ***	4.80 ***	0.0289	9.54 ***	9.10 ***	4.79 ***	5.04 ***	0.0303	9.95 ***	9.43 ***	5.10 ***	5.25 ***
-1 to 0	597	0.0252	10.37 ***	9.28 ***	5.18 ***	5.88 ***	0.0254	10.60 ***	9.79 ***	5.20 ***	6.18 ***	0.0265	10.99 ***	10.10 ***	5.48 ***	6.43 ***
Day 0	616	0.0228	13.34 ***	11.86 ***	5.98 ***	7.20 ***	0.0233	13.83 ***	12.70 ***	6.16 ***	7.64 ***	0.0246	14.22 ***	13.26 ***	6.61 ***	7.76 ***

Z(DW)/(BW)/(CS)/(Corr) – Z-Statistic for Dodd-Warner/BrownWarner/Cross-sectionally standardized/Corrado tests
***/**/* significance 1%/5%/10%

Table 12 (continued): Results of Event Study by Day over Event Period (All Alliance-Related Events)

Day	N	Market Model (STOXX600)				
		AAR	Z (DW)	Z (BW)	Z (CS)	Z (Corr)
-10	647	0.0002	0.10	0.08	0.10	0.31
-9	650	-0.0021	-1.20	-1.12	-1.03	-0.99
-8	655	-0.0013	-0.75	-0.70	-0.50	-1.88 *
-7	647	0.0002	-0.12	0.09	0.09	-0.53
-6	644	0.0005	0.29	0.28	0.27	-0.31
-5	641	0.0020	1.25	1.06	0.92	0.38
-4	658	0.0003	0.03	0.16	0.18	0.11
-3	657	0.0020	1.09	1.09	1.27	1.36
-2	652	0.0004	-0.19	0.22	0.20	-0.08
-1	641	0.0016	0.90	0.86	0.86	0.11
0	616	0.0246	14.22 ***	13.26 ***	6.61 ***	7.76 ***
1	645	0.0017	0.65	0.93	0.77	1.22
2	642	-0.0050	-3.11 ***	-2.72 ***	-2.59 ***	-1.20
3	642	-0.0010	-0.37	-0.52	-0.59	-0.08
4	647	-0.0018	0.16	-0.94	-1.06	-0.58
5	646	-0.0003	-0.89	-0.16	-0.17	-0.07
6	643	0.0013	0.21	0.68	0.51	-0.08
7	627	0.0041	2.05 **	2.23 **	2.09 **	1.05
8	639	-0.0047	-2.52 **	-2.52 **	-2.98 ***	-2.14 **
9	639	0.0001	-0.14	0.03	0.03	-0.69
10	648	-0.0012	-1.09	-0.66	-0.77	-0.18

Z(DW)/(BW)/(CS)/(Corr) – Z-Statistic for Dodd-Warner/Brown-Warner/Cross-sectionally standardized/Corrado tests
***/**/* indicates significance at 1%/5%/10% levels

In spite of these differences, all estimation and testing procedures agree that the event announcement itself increases collaborative value, some of which may be reduced by profit taking in the days following the announcement.[444]

Next, the individual securities' abnormal returns were aggregated and averaged across 11 different multi-day windows. These event windows were chosen to allow comparison to prior research in the area of collaborative value creation.[445] As for daily AARs, the three parametric significance

[444] Findings for alliance formation announcements, accounting for about half of all events, are highly similar. In the interest of brevety, the corresponding results are provided in the Appendix (Table 125 and Figure 60).

[445] See subsection 4.3.2.2 and Table 51 of the appendix for a comparison of prior literature.

tests and the Corrado rank test were performed. The results are shown in Table 13.

The aggregate event-study analysis provides a clear picture regarding the valuation effects of alliance-related news. CAARs are positive and, with the exception of the 21-day (–10 to +10) and one of the two 12-day (–1 to +10) event windows, statistically different from zero. Similarly, longer event periods are associated with greater ARs than the announcement day itself, if limiting the weight of the post-announcement period. In particular, all event windows up to 11-days in length (centered around the announcement date) consistently exhibit significant ARs. The insignificance of ARs in the two specific cases thus may be due to the profit-taking behavior towards the end of the observation period (days +8 and +10) in combination with the difficulties of detecting statistical significance in longer event windows.

As the 5-day event window ranging from day –3 to +1 reveals the numerically highest CAARs, some value-related information may be processed before or immediately after the event. However, the magnitude of test statistics steadily declines with expanding event windows, indicating that the main value effect is sufficiently reflected in shorter event windows.[446]

[446] Additionally, the higher number of confounding news in larger event windows reduces the numbers of observations and may explain the declining level of significance. Note that the substantially larger summed AARs exhibited in Figure 36 are at least in part also due to confounding events during the 21-day event-period. See FN 439.

Table 13: Results of Event Study by Event Windows (All Alliance-Related Events)

Win-dow	N	Market Model (Stoxx600)					2-Factor-Model (Local/StoxxBiotech)				
		CAAR	Z (DW)	Z (BW)	Z (CS)	Z (Corr)	CAAR	Z (DW)	Z (BW)	Z (CS)	Z (Corr)
-10 to +10	277	0.0067	0.37	0.76	-0.58	0.51	0.0099	0.82	1.18	-0.35	0.66
-10 to +3	398	0.0261	2.78 ***	3.62 ***	1.68 *	2.11 **	0.0283	3.15 ***	4.12 ***	1.89 *	2.17 **
-10 to +1	427	0.0316	4.26 ***	4.74 ***	2.61 ***	2.71 ***	0.0322	4.39 ***	5.07 ***	2.64 ***	2.66 ***
-1 to +10	417	0.0066	0,89	0.99	0,33	0.36	0.0098	1,31	1.55	0,68	0.74
-5 to +5	428	0.0237	3.12 ***	3.72 ***	1.56	2.29 **	0.0250	3.36 ***	4.12 ***	1.69 *	2.26 **
-3 to +3	500	0.0254	4.73 ***	4.99 ***	2.39 **	3.24 ***	0.0273	5.19 ***	5.63 ***	2.71 ***	3.30 ***
-2 to +2	524	0.0238	5.16 ***	5.52 ***	2.31 **	2.71 ***	0.0252	5.64 ***	6.15 ***	2.58 **	2.95 ***
-3 to +1	532	0.0320	7.70 ***	7.43 ***	4.37 ***	4.51 ***	0.0321	7.78 ***	7.82 ***	4.37 ***	4.39 ***
-2 to +1	547	0.0280	7.40 ***	6.50 ***	3.85 ***	3.97 ***	0.0286	7.64 ***	6.96 ***	3.95 ***	4.08 ***
-1 to +1	564	0.0285	9.30 ***	8.54 ***	4.71 ***	4.80 ***	0.0289	9.54 ***	9.10 ***	4.79 ***	5.04 ***
-1 to 0	597	0.0252	10.37 ***	9.28 ***	5.18 ***	5.88 ***	0.0254	10.60 ***	9.79 ***	5.20 ***	6.18 ***

Z(DW)/(BW)/(CS)/(Corr) – Z-Statistic for Dodd-Warner/Brown-Warner/Cross-sectionally standardized/Corrado tests
***/**/* indicates significance at 1%/5%/10% levels

Table 13 (continued): Results of Event Study by Event Windows (All Alliance-Related Events)

Window	N	Market Model (Intra-Sample Index)				
		CAAR	Z (DW)	Z (BW)	Z (CS)	Z (Corr)
-10 to +10	277	0.0128	1.15	1.54	-0.26	0.77
-10 to +3	398	0.0268	2.92 ***	3.86 ***	1.61	1.66 *
-10 to +1	427	0.0312	4.11 ***	4.95 ***	2.43 **	2.16 **
-1 to +10	417	0.0157	1,76 *	2.38 **	1,52	1.48
-5 to +5	428	0.0295	3.99 ***	4.79 ***	2.19 **	2.70 ***
-3 to +3	500	0.0284	5.46 ***	5.77 ***	2.72 ***	3.44 ***
-2 to +2	524	0.0282	6.43 ***	6.80 ***	3.12 ***	3.50 ***
-3 to +1	532	0.0345	8.33 ***	8.31 ***	4.74 ***	4.64 ***
-2 to +1	547	0.0312	8.32 ***	7.52 ***	4.50 ***	4.51 ***
-1 to +1	564	0.0303	9.95 ***	9.43 ***	5.10 ***	5.25 ***
-1 to 0	597	0.0265	10.99 ***	10.10 ***	5.48 ***	6.43 ***

Z(DW)/(BW)/(CS)/(Corr) – Z-Statistic for Dodd-Warner/Brown-Warner/Cross-sectionally standardized/Corrado tests
***/**/* indicates significance at 1%/5%/10% levels

While this evidence provides insights into alliance-related information processing, the substantive hypotheses derived in 3.3.2 require further distinction of the different types of such events.

5.1.2 Abnormal Returns by Event Category

As indicated in subsection 4.2.1.1, seven major types of alliance-related news were distinguished. In addition to alliance formation, these reflect the adaptation (i.e., expansion, extension, or modification), progression (i.e., milestone and clinical advancement) and termination of alliances. Furthermore, announcements relating to multiple alliances, alliances outside the human health sector, rumors on alliance formation and announcements previously publicized alliances are used as control cases.[447]

The evidence in Table 14 provides a comprehensive assessment of collaborative value creation. The main pieces of evidence are quite consistent across different event windows, return models, and statistical tests.[448] In particular:

- Alliance formation induces significantly positive wealth gains across all event windows, with the exception of the post-announcement period (here: -1/+10 window). This effect is similar in significance and potentially larger in magnitude for announcements relating to ‘multiple’ alliances or taking ‘other’ forms (e.g., asset sales).
- Alliance expansion is associated with substantial and significant announcement gains around the announcement date (up to 7-day event window), but aggregate returns over longer time horizons are insignificant. The announcement ARs on alliance extensions and modifications are minimal and insignificant across all event windows.
- The achievement of collaborative ‘milestones’ yields significant ARs on and around the announcement days. The magnitude of these wealth gains even appears to exceed that of alliance announcements. However, the level of significance is not consistent across event windows and test statistics. In particular, CAARs are insignificant for the 7-, 11-, and one of the 12-day (-1/+10) windows, indicating that the value quickly degenerates in the post-formation period. ‘Clinical’ advancement (i.e., the initiation of further alliance activities) does not yield significant ARs.
- Alliance termination results in significantly negative ARs on the announcement day. This effect, however, is limited to the Dodd-Warner and Corrado test statistics. Additionally, the negative significance does not persist across all event windows. In particular, medium length (3-7 days) windows report insignificant results, whereas short- and longer-term perspectives show significantly negative results on standardized CAARs.[449]

447 Specifically, ‘multiple’ and ‘other’ alliance announcements (as well as some ‘rumors’) should entail a significant market reaction, whereas restatement of existing information (‘follow’) should not.

448 While the tables included in the text are only based on the standard market model, the results obtained for the 2-Factor-Model and the Intra-Sample-Model are highly similar (also see FN 444 and Table 126 of the appendix).

449 Note that while non-standardized CAARs are positive for the 11- and 12-event windows, the Dodd-Warner-type test results are significantly negative. As this approach standardizes daily returns, the wealth gains reported by some

- Finally, among the news items included for control purposes, the reiteration of previously announced alliances at a later point in time does not affect corporate value, which supports the basis premise that efficient capital markets only react to actual news. Conversely, public rumors on alliances (generally concerning alliance formation) are associated with some wealth implications. The pattern of these ARs is peculiar, since short-to-medium windows around the announcement date (i.e., 4 and 7 days) exhibit significant value gains, although the announcement-day returns themselves are insignificant. A comparison of the two 12-day windows indicates that stock returns are negative prior the 'rumored news', whereas they are highly positive for the post-formation period.[450]

These results need to be interpreted with some caution, since some of them are based on reasonably small subsamples. Additionally, the significance of some findings varies across testing procedures. In particular, the cross-sectionally standardized and Corrado rank statistics appear more powerful in medium- to long-term event windows. This suggests that findings may be sensitive to cross-sectional heterogeneity in the ARs, which also may be the root of non-normality. That is, high-AR events are the primary source of positive ARs as opposed to a general but moderate increase in firm value. For shorter event-windows (e.g., 1 to 5 days for alliance formation), however, findings are consistent across all test statistics.

firms around alliance termination are smaller relative to the firms' historic volatility than the wealth losses experienced by other firms.

450 Similar to the case of alliance termination, the effects of alliance rumors are not homogeneously significant across test statistics. Specifically, the Brown-Warner-type test consistently provides a more positive assessment than the Dodd-Warner-type statistic (long-window negative significance). Consequently, the positive value of rumors is mostly driven by securities also underlying a higher volatility in general (i.e., during the estimation period). Additionally, significantly positive abnormal returns following the announcement (esp. day +1) render CAARs positive on average.

Table 14: Results of Event Study by Event Category for Different Event Windows (Based on Stoxx600 Market Model)

Event	12-Day Window (-10/+1)						12-Day Window (-1/+10)						11-Day Window (-5/+5)					
	N	CAAR	DW	BW	CS	Corr	N	CAAR	DW	BW	CS	Corr	N	CAAR	DW	BW	CS	Corr
Formation	244	0.0373	***	***	**	***	228	0.0118					243	0.0239	***	***		***
Expansion	25	0.0173					26	-0.0094					25	0.0267				
Extension	9	-0.0106					10	0.0221					8	-0.0364				
Modification	15	-0.0007					12	-0.0478					16	-0.0262				
Milestone	62	0.0335	*	*			56	-0.0089					60	0.0396	**	**		
Clinical	9	0.0136				*	13	-0.0119					11	0.0043				
Termination	15	0.0089	**				15	0.0532					14	0.0381	*			
Multiple	8	0.0772	**	**			6	0.0397				*	6	0.0786	**	**		
Other	16	0.0990	***	***	**	*	14	0.0139					15	0.1055	***	***	***	
Rumor	6	-0.0559	**				7	0.0831		**			6	0.0051				*
Follow	22	-0.0013					30	-0.0175					27	-0.0220				

DW/BW/CS/Corr – Signifiance of Dodd-Warner/Brown-Warner/Cross-sectionally standardized/Corrado tests
***/**/* indicates significance at 1%/5%/10% levels

Table 14 (continued): Results of Event Study by Event Category for Different Event Windows (Based on Stoxx600 Market Model)

Event	7-Day Window (-3/3)						4-Day Window (-2/1)						2-Day Window (-1/0)					
	N	CAAR	DW	BW	CS	Corr	N	CAAR	DW	BW	CS	Corr	N	CAAR	DW	BW	CS	Corr
Formation	279	0.0258	***	***		***	301	0.0282	***	***	***	***	311	0.0296	***	***	***	***
Expansion	32	0.0490	**	**			35	0.0414	***	**			37	0.0391	***	***	**	***
Extension	11	0.0068					13	-0.0067					14	0.0025				
Modification	17	0.0065					17	0.0149					17	0.0171				
Milestone	69	0.0210					76	0.0284	***	**			81	0.0324	***	***	**	***
Clinical	12	0.0207					13	0.0109				**	14	-0.0027				
Termination	17	0.0462					19	0.0620			***		19	-0.0213	***			*
Multiple	9	0.0904	***	***		*	9	0.0945	***	***	**	**	9	0.0591	***	***		**
Other	16	0.0604	**	***	**		17	0.0450	***	**	*		18	0.0171	*			
Rumor	6	0.0906		***			8	0.0543		**			9	0.0080				
Follow	35	-0.0281	*	*			39	-0.0086					39	0.0068				

DW/BW/CS/Corr – Signifiance of Dodd-Warner/Brown-Warner/Cross-sectionally standardized/Corrado tests
***/**/* indicates significance at 1%/5%/10% levels

Overall, the event-study thus supports Hypotheses 1-3, which argue that alliance formation, termination, and post-formation events (i.e., adaptation and progression) substantially impact corporate value. In particular, these findings create a colorful picture of post-formation value dynamics:

First, with regard to the flexibility to adapt alliances, the present study documents significantly positive returns to alliance expansion but neither to extension nor modification. This may reflect that alliance expansion is a more pronounced indicator of collaborative success than mere alliance extension or modification. The expansion of an alliance may build on technological progress, signal mutual trust, and open additional sources of value generation. In contest, alliance extension may indicate work-in-progress and alliance modification may be indicative of mutual understanding, but also suboptimal performance or changes in the intra-alliance power structure. Most generally, the insignificance of extension and modification announcements suggests that the flexibility inherent in strategic alliances may not be valuable per se. This would be contrary to the general logic underlying Hypothesis 3.[451] Alternatively, these flexibilities may have been correctly ‘priced’ at the time of alliance formation. The (expected) flexibility value of extending or modifying an alliance will have been part of the formation ARs.

Second, with regard to the operational progress of collaborative ventures, the results indicate positive valuation effects for the completion of tasks (milestones) as opposed to insignificant returns on the continuation of activities. This may again indicate that the market only values actual news. The achievement of milestones reveals new technological information concerning the stage and state of the collaboration. Given such prior information, the advancement of collaborative activities (e.g., into subsequent stages of development) may be anticipated. Additionally, the achievement of milestones is often associated with financial payments between alliance partners. The observed value gains thus reflect increases in the value of collaborative projects, in which the focal firm either continues to hold an interest or participates through milestone payments.

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451 While the dynamic perspective highlights the strategic adaptive advantages of collaboration, TCE refers to the need to adapt as a source of coordination costs. The findings presented here, however, do not distinguish between these two elements, representing a joint hypothesis test. Consequently, the overall insignificant ARs may also result from adaptive gains being mitigated by intra-alliance rivalry. See subsection 2.3.1.1 (especially FN 117) for the notion that high levels of uncertainty may increase the benefits of hierarchical (rather than hybrid) coordination.

Third, alliance termination results in short-term wealth losses. This is congruent with the limited prior evidence on alliance termination [e.g., (Häussler 2006)]. Beyond the actual announcement-day effect, however, termination may not substantially destroy value. In the given context, this contradictory evidence may be attributed to a variety of factors. On one hand, alliance termination may not always be actual news to informed market participants. Since DBFs regularly report on collaborative progress, the market may anticipate alliance termination following less than satisfactory progress reports.[452] This explanation would also be in line with the evidence that short-term wealth losses are primarily significant for firms subject to low volatility during the estimation period (i.e., Dodd-Warner test). On the other hand, alliance termination may also create new opportunities, which may partially compensate for the disadvantages of alliance discontinuation. In particular, the termination of outbound alliances, i.e., collaboration providing the partner with rights to proprietary drug candidates or technologies, usually results in these rights being returned to the focal firm. Given that termination decisions may result from factors other than outright technological or market failure (e.g., misfits within partner portfolio), the focal firms may continue working on the project alone or in collaboration with new partners. This represents an intermediate case between discontinuation of failed projects and the alliance internalization, which may be valuable.[453] A further analysis of these issues would require cross-sectional analysis taking into account the direction of resource flows and the existence of (negative) milestone announcements, among other items. Given the small size of the termination subsample, however, this is not feasible.

5.1.3 Summary of Event-Study Findings

This subchapter has reported and discussed the results of the event-study analysis on different types of alliance-related news announcements. Across

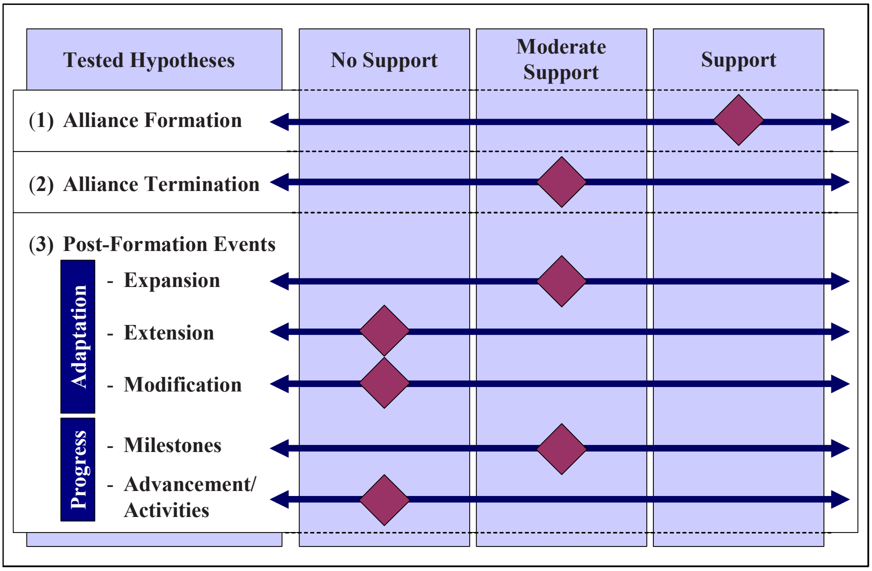
[452] Consequently, milestone and termination announcements may not be fully independent from each other, which would violate the basic assumptions underlying event-study analysis. In the present study, however, the share of non-positive milestone announcements is neglibibly small. Moreover, such information is often first reported as part of the termination announcement itself. Nonetheless, the market may have anticipated alliance termination without explicit news on collaborative failure, e.g., based on rumors or the lack of positive milestone announcements.

[453] See (sub-)sections 2.4.2.3 and 3.1.3 regarding the value potential of alliance/JV internalization.

all types of alliance-related news, the present study has documented a positive and significant value impact using a variety of event windows, estimation and testing procedures. In particular, the observed wealth gains only become insignificant when fully considering a 10-day post-announcement period, during which investors may have capitalized (i.e., cashed-in) on the announcement returns.

The findings are highly similar for the subsample of alliance formation announcements, which represents about half of all events. With regard to other types of collaborative news, the event study has observed positive ARs to announcements on the expansion of collaborative activities and on the achievement of collaborative milestones. Similarly, alliance termination results in significantly negative (short-term) announcement returns. Conversely, alliance extension, modification, and the advancement of collaborative activities does not result in significant valuation effects. All-in-all, these findings support the basic notion that alliance-based value is realized sequentially, although this effect is limited to announcements reflecting clearly positive (or negative) developments and having an air of novelty, whereas the realization of standard flexibilities may be well anticipated. Figure 37 summarizes these findings.

Figure 37: Summary of Findings (Hypotheses 1-3)



Source: Own Illustration

The following subchapters extend this analysis by considering factors explaining the cross-sectional variation of ARs. They focus on alliance formation announcements, for which detailed hypotheses were derived in section 3.3.2.[454]

5.2 Univariate Analysis of Value Impact

The present section lays the groundwork for the multivariate analysis of ARs by assessing the bivariate relationships between ARs and explanatory variables as well as amongst the various transaction, firm, and environmental characteristics.

Table 15 provides an overview of these correlations with regard to the most relevant environmental and firm-level variables.[455] The middle block of figures presents the univariate correlations of each variable with the two-day ARs using either of the three return models. [456] The right-hand block focuses on the correlations between the explanatory variables.

[454] Given the evidence on other alliance-related news presented in this subchapter, a more detailed analysis on some of these events might also be worthwhile (e.g., the value of collaborative milestone announcements vis-à-vis proprietary research results). Doing so would, however, exceed the scope of the present research and might be hampered by the infrequence of some event types. Additionally, many aspects of sequential collaborative value creation (e.g., flexibilities) may be anticipated and incorporated at the time of alliance formation.

[455] Due to the great number of transaction-level variables (especially dummies) used in this study, such a summary is infeasible with regard to transaction characteristics. Table 128 and Table 129 of the appendix provide a similar discussion for these variables. The various correlations are shown in Table 132 to Table 134 of the appendix.

[456] Note that the ARs in this table were calculated using different estimation models. At the same time, some relationships may vary across event windows. Due to space constraints, these correlations are presented in Table 130 to Table 133 in the appendix. Similarly, Table 135 to Table 138 present correlations among explanatory variables; in particular, the relationship between firm development and different transaction characteristics.

Table 15: Table of Correlations (Environmental & Firm-Level Variables)

Variables Name	Description	Correlations with Abnormal Returns carMM2	car2F2	carBTi2	Correlations among Explanatory Variables (a) fstaff	(b) agep	[c]	[d]
Panel I	Focal Firm Variables							
focalstaff	No. of Employees	-0.1167 **	-0.1252 **	-0.1233 **	1			
Agep	No. of Months since IPO	-0.0736	-0.0714	-0.0813	0.7691 ***	1		
focalsales	Sales in k	-0.1128 **	-0.1161 **	-0.1090 *	0.9223 ***	0.7424 ***	1	
focalassets	Assets in k	-0.1101 **	-0.1170 **	-0.1147 **	0.9130 ***	0.7381 ***	0.9262 ***	1
focalmve	Market Value in k	-0.1086 *	-0.1125 **	-0.1061 *	0.8601 ***	0.6900 ***	0.8443 ***	0.8621 ***
Focalp5	No. of Patents (5-year Window)	-0.0607	-0.0600	-0.0841	0.1924 ***	0.2525 ***	1	
Focalp3	No. of Patents (3-year Window)	-0.1185 **	-0.1287 **	-0.1533 ***	0.1953 ***	0.1255 **	0.7424 ***	1
experience	No. of Prior Alliances	-0.0893	-0.0905	-0.1014 *	0.3827 ***	0.4231 ***	0.4105 ***	0.5075 ***
focalebit	EBIT in k	-0.0460	-0.0447	-0.0414	0.3948 ***	0.3205 ***	1	
focalncf	Net Cash-Flow in k	0.0311	0.0126	0.0180	0.2241 ***	0.1547 ***	0.2242 ***	1
Focalq	Tobin's q	0.0247	0.0365	0.0325	-0.0092	-0.0089	0.1497 **	0.0095
Panel IIa	Partner Firm Variables							
Pstatus	Dummy Public Listing	0.1136 **	0.1042 *	0.1211 **	0.0254	0.058	1	
Pp	No. of Patents (5-year Window)	0.0773	0.0750	0.0783	-0.0794	-0.0518	0.1913 ***	1
Ptrans	No. of Prior Alliances	0.1514 ***	0.1450 ***	0.1452 ***	-0.0315	0.0785	0.3744 ***	0.1556 ***

***/**/* indicates significance at 1%/5%/10% levels

Figures indicate parametric correlation / spearman rank coefficients (ρ)

Table 15 (continued): Table of Correlations (Environmental & Firm-Level)

Variables Name	Description	Correlations with Abnormal Returns carMM2	car2F2	carBTi2	Correlations among Explanatory Variables (a) fstaff	(b) agep	[c]	[d]
Panel II b	Partner Firm Variables							
ptype_ph	Pharmaceutical Dummy	0.1374 **	0.132 **	0.1248 **	-0.0693	-0.0099	1	
ptype_bt	Biotechnology Dummy	-0.0755	-0.0701	-0.0623	0.1619 ***	0.1123 **	-0.5868 ***	1
ptype_res	Research Institution Dummy	-0.0538	-0.0488	-0.0463	-0.108 *	-0.1032 *	-0.1817 ***	-0.3251 ***
Pregion_us	North American Dummy	0.0171	0.0029	0.0184	0.1263 (**)	0.082	1	
Pregion_eu	European Dummy	0.042	0.0566	0.0447	-0.0738	-0.0399	-0.7853 ***	1
Pregion_j	Japanese Dummy	-0.0594	-0.0602	-0.0682	-0.0215	-0.0167	-0.2019 ***	-0.1731 ***
Panel III	Environmental Variables							
mktactivity	No. of Alliances/M&A (12-month)	-0.0375	-0.0456	-0.0498	-0.0155	-0.0142	1	
mktretbt	Return on Market Index (200 days)	-0.0717	-0.0509	0.0003	-0.0707	0.062	-0.4732 ***	1
mktvolbt	Market Index Volatility (200 days)	-0.1003 *	-0.0869	-0.0733	-0.0489	-0.0232	0.3318 ***	0.2926 ***

***/**/* indicates significance at 1%/5%/10% levels

Figures indicate parametric correlation / spearman rank coefficients (ρ)

5.2.1 Correlations of Focal Firm Variables

As suggested by Control 5, focal firm size appears to be negatively related to abnormal collaborative gains. All size-related indicators, i.e., number of employees, sales, assets, and market value of equity, exhibit significantly negative correlations to CAR measures across different estimation models and event windows. This negative correlation also appears to extend to focal firm resources, although it is only significant for the anticipatory patent measure, i.e., the number of patents issued during the three years following the alliance announcement. Consequently, firms possessing sufficient internal resources may not profit from accessing external resources by collaborative means.[457]

Not surprisingly, all indicators of focal firm size and resource endowments are highly correlated. In particular, the employee-, sales-, and asset-based measures of firm size are almost identical (all ρs > 0.91). Similarly, the two patent count variables exhibit high correlation (ρ= 0.74).[458] Multicollinearity may also be a concern with regard to alliance experience (Control 7), which substantially correlates with focal firm size (ρ= 0.38) and both patent portfolio measures (ρ= 0.41/0.51). Consequently, firm size has to be considered as a necessary control variable not only for its main effect but also as it interacts with other firm characteristics.

5.2.2 Correlations of Partner-Firm Variables

In line with Control 6, partner firm resource indicators are positively associated with collaborative value creation. Specifically, the correlations of the public listing dummy and partner firms' numbers of prior transactions are significant and partner firms' patent bases also show positive correla-

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457 As firm age is not significantly related to abnormal announcement gains, the negative value impact of firm size may be rooted in substantive causes (i.e., lower value of partner resources) rather than discounts on little-known firms (i.e., information asymmetries).

458 While focal firms' patent portfolios were not argued to directly affect collaborative value creation, prior research has identified them as facilitating alliance formation (see subsection 2.2.2.2). Consequently, one of the measures will be used for assessing the selection bias arising from alliance formation (see section 4.5.3). Additionally, the focal firms' technological capabilities may yield absorptive capacity, which was tested in complementary analyses reported in Table 172 of the appendix.

tions.[459] The dummy indicating that the partner is a pharmaceutical firm is significantly positive, supporting the notion that European DBFs may most profit from collaborating with established downstream entities, i.e. pharmaceutical firms (Control 2). In contrast, partner firm origin (Control 3) does not significantly correlate with ARs.[460]

With regard to the correlations among explanatory variable, the public status dummy correlates significantly with the other relevant partner firm characteristics, i.e., patent count and social capital (prior alliances). Consequently, the effects of partner firms' resource endowments may be closely intertwined and difficult to dissect.[461] Furthermore, focal firm size appears to modestly influence collaborative behavior. In particular, it correlates positively with the biotechnology-partner dummy and negatively with the research institution dummy. That is, larger firms may be more inclined to collaborate horizontally (with other DBFs) rather than draw on fundamental research conducted by research institutions.

5.2.3 Correlations of Environmental Variables

Contrary to Control 4 and Hypotheses 10 and 11, all environmental variables in Table 15 are negatively correlated to collaborative wealth gains.[462]

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[459] This correlation is significant for the announcement day itself (not reported here) but insignificant for all other windows). Similarly, these findings are also consistent for measures adjusted for parent firm resource endowments if the partner itself is a subsidiary. However, the public listing dummy looses its significant correlation with ARs in this case. This suggests that the benefits of partners' commercial resources arise from their direct access to capital markets.

[460] Yet collaboration with Japanese and other (not reported here) firms shows negative correlation coefficients as opposed to the positive ones for alliances with North American and especially European partners. Consequently, the main difference may lie between the largest and culturally most closely related regions (North America and Europe) and the other origins.

[461] Similarly, the pharmaceutical-partner dummy also is highly correlated to partner status and shows an even greater association with technological and social capital. Consequently, either big-pharma or public partner variables have to be considered in multivariate models to account for parter characteristics. Conversely, considering prior partner alliances may lead to multicollinearity problems due to their correlation with partner status and relatedness.

[462] Note that the association between the market-climate indicator (200-day returns) and CARs is almost dead zero for the market-adjusted return model employing this index. As all other parameters are quite consitent across estimation models, this suggests that the negative correlation may reflect failure

However, the only significant relationship is between market volatility (i.e., the proxy for environmental uncertainty) and the CARs calculated based on the standard market model. Still, the proposed valuation effects of alliance-based adaptation and flexibility appear poorly supported by the present data.[463]

As expected, stock-market returns and volatility are positively and significantly correlated. In addition, transaction activity index is negatively related to the stock-market climate (i.e., returns) and positively to uncertainty (i.e., volatility). This supports the general premises underlying Control 4 and Hypothesis 11 that alliances are formed to facilitate adaptation and provide flexibility in unfavorable, highly uncertain market environments.

5.2.4 Summary of Univariate Analyses

In general, the analysis of correlations lays the groundwork for the subsequent multivariate analysis. On the firm level, focal firm and partner characteristics appear to have a relatively consistent influence on value generation. In particular, focal firm size and resources are associated with lower collaborative value, while partner firm resources positively correlate with ARs. On the environmental level, market activity and conditions appear to have little general effect on collaborative ARs, but may be substantially interrelated amongst themselves. These as well as the multitude of contextual, structural, and financial transaction characteristics require more extensive analysis. Thus, section 5.3 will commence on the firm level and sequentially add transaction and environmental parameters to multivariate analyses.

5.3 Multivariate Analysis of Collaborative Value Creation

In contrast to the preceding correlation analysis, multivariate models simultaneously consider the effects of explanatory variables on value creation as well as their interrelations amongst each other. The analyses proceed as follows: Section 5.3.1 develops basic models only accounting for

to correct for the specific market-segment returns. Alternatively, this effect may be due to the endogeneity bias inherent in this index.

463 Since market-dynamics-related variables are not directly associated with ARs, they may be further explored without being included as standard control variables.

control factors. The more elaborate models in section 5.3.2 then consider the hypothesized effects. Finally, section 5.3.3 assesses the validity of inference and presents models adjusted for methodological concerns.

5.3.1 Models Testing for Control Effects

5.3.1.1 Environmental and Firm-Level Base Models

The base models in this subsection include the variables accounting for environmental influences as well as (focal and partner) firm characteristics outlined in sections 3.2.1 and 3.2.2. Table 16 exhibits the most important models for each control hypothesis.[464]

On the environmental level, differences among industry segments (Control 1), in the relatedness of collaborating partners (Control 2), and the international scope of collaboration (Control 3) represent the market-oriented perspective. Several models were estimated to assess systematic differences between therapeutic target indications, the effect of horizontal, downstream, and upstream alliances as well as different partner origins. The findings are straightforward:

- ARs do not systematically vary across market segments. Neither in isolation nor correcting for other industry and firm characteristic did any medical indication dummies gain statistical significance (see Table 139 in the appendix).[465] The apparent irrelevance of inter-segmental differences may indicate that other firm and/or transaction characteristics such profound valuation effects that the market segments targeted become irrelevant. Alternatively, the value impact may differ within the identified medical indications (e.g., by types of cancer).[466] In any case, Control 1

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464 Due to space constraints, the more extensive estimation results are shown in Table 139 to Table 148 of the appendix. The base models presented in Table 16 were selected based on their explanatory power, measured by adjusted R^2- and F-statistics. When collapsing multiple dummy variables, a Hausman (1978)-type specification test was employed to assure unbiasedness of other variables' coefficient estimates.

465 No model accounting for industry-segment effects was included in Table 16 due to their consistent insignificance. Furthermore, Hausman (1978)-type tests showed that models were correctly specified even when dropping the medical indication dummies.

466 Also, the fairly large share of collaborations not targeting specific indications (see 4.2.1.2) may reduce the precision of inference, since all reported indications are benchmarked against this category.

does not appear significant in the present setting and will not be pursued further.

- In line with the correlation analysis, downstream alliances with pharmaceutical firms are associated with significantly higher ARs than other alignments (model 'Control 2' in Table 16). This supports Control 2 that alliances addressing the downstream bottleneck faced by European DBFs increase collaborative value. The slightly negative effect of horizontal alliances (with other biotechnology firms) observed in bivariate correlations (see Table 15) does not appear significant in a multivariate setting, i.e., in comparison to upstream or unrelated alliances (also see Table 139 in the appendix).
- In favor of Control 3, partner firm origin appears to affect collaborative value creation. Correcting for downstream alliance orientation (for other controls see Table 140 of the appendix), regional dummy variables exhibit a clear pattern since both European (pregion_eu) and North American (pregion_us) partners have substantially positive coefficients. Consequently, collaborations involving partner firms from these two largest pharmaceutical markets worldwide (pregion_main) yield significantly higher abnormal returns even after controlling for other factors (model 'Control 3' in Table 16).[467]

[467] Specifically, including *pregion_main* in addition to *ptype_ph* yields better overall model fits and does not affect the significance of other partner or focal firm variables. See Table 140 of the appendix.

Table 16: Selected Environmental and Firm-Level Base Models[468]

Variable	Control 2	Control 3	Control 5	Control 6	Control 7	Control 9
ptype_ph	0.0367 **	0.0368 **	0.0346 **	0.0344 **	0.0132	0.0290 *
pregion_main		0.0402 *	0.0453 **	0.0450 **	0.0392 *	0.0468 **
focalstafflog			-0.019 ***	-0.0195 ***	-0.019 ***	-0.0199 ***
experience				0.0000		
pstatus					0.0102	
ptrans					0.0001	
Pp					0.0000	
focalebit						0.0000
focalncf						0.0000
focalq						0.0004
intercept	0.0206 ***	-0.0157	0.0851 **	0.0872 **	0.0820 **	0.0888 **
df	326	325	313	312	310	278
R^2	0.0159	0.0236	0.0550	0.0520	0.0562	0.0430
F	6.2715	4.9604	7.1274	5.3339	4.1359	3.1271
AIC	-489.37	-490.98	-475.40	-473.42	-472.86	-396.98

***/**/* indicates significance at 1%/5%/10% levels

468 Control 4 (environmental munificience) and Control 8 (prior relations) were intentionally left out of this section. As they pertain to the value of specific transaction structures (e.g., resource access, information asymmetry), they are considered together with the transaction-level controls in the subsequent section.

On the firm-level, focal firm size (Control 5), alliance experience (Control 7), and performance (Control 9) as well as partner firms' resource bases (Control 6) may affect collaborative value creation:

- Firm size exerts a significantly negative influence ARs after controlling for market-related factors, supporting Control 5. In comparison to the commonly used sales- and market-value-based proxies, the number of employees (*focalstaff*) and firm assets (*focalassets*) exhibit the greatest explanatory power (see Table 142 in the appendix), i.e., having the highest adjusted R^2 and F as well as the most negative AIC values.[469] Further examination the relationship's functional form indicated substantial non-linearity.[470] While the main effect is negative, it declines at the margin. Overall, log-transformation of the focal firms' number of employees yielded the best model fit and was used as a reference for further analyses (model 'Control 5' in Table 16).
- Contrary to Control 7, alliance experience does not appear to be a significant value driver after controlling for focal firm size. This contrasts with the negative univariate correlation between the number of prior alliances (*experience*) with ARs demonstrated in Table 15. The negative value impact of firm size thus may have overshadowed *experience*, which has a coefficient of close to zero and remains far from significant (model 'Control 7' in Table 16 as well as Table 144 in the appendix). One possible reason for this insignificance may be the general importance of alliance activity in biotechnology. Specifically, managerial attention to alliance operations may differ less between companies of different experience levels than in other settings.
- The agency costs of free cash flows (or firm performance in general) appear to be limited. In contrast to Control 9, none of performance indicators (EBIT, net cash flows) or Tobin's q[471] exhibits a significant rela-

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[469] In the correlation analysis, *focalassets* showed the highest level of correlation with other focal firm variables (see Table 127 of the appendix). Since it is thus more difficult to distinguish size from other firm-level effects (e.g., technological resources), when using *focalassets* as a proxy, the present study instead relies on *focalstaff*.

[470] In addition to the econometric evidence presented in Table 142, plots of the dependent against each independent variable were inspected and substantiated the observed non-linearity.

[471] As Tobin's q builds on the focal firms' market value, it may similarly reflect environmental influences However, q is most commonly regarded as reflecting the focal firms' internal growth opportunities and thus is a reasonable indicator of (low) agency costs. Specifically, valuable internal growth options reduce the risk of management investing funds in negative-NPV projects (see subsection 4.2.2.2, in particular FN 354).

tion to announcement ARs (model ‘Control 9’ in Table 16). Similar to alliance experience, the concerns about agency conflicts between managers and shareholder may not be severe in the biotechnology industry, since they are generally strongest in mature industry settings [cf. (Jensen 1986)].[472]

- Correcting for downstream collaboration with pharmaceutical firms, partners’ publicly traded status (pstatus), number of prior transaction (ptrans) and patent portfolio (pp) have no significant effects and only marginally improve model fit. At the same time, they negate the significance of the pharmaceutical-partner dummy (model ‘Control 6’ in Table 16). Due to their high level of correlation, downstream relatedness and focal firm resources thus overshadow each other. In particular, the downstream dummy and the social capital measure (ρ=0.5993, see Table 138 in the appendix) overlap substantially.[473] While they will thus not be further included as control variables, all three partner resource variables are highly significant in isolation, supporting Control 6.

In summary, the evidence presented in Table 16 indicates that environmental, focal and partner firm variables have separate and distinguishable effects on ARs. Specifically, collaborative ventures by smaller DBFs with Big Pharma partners from Europe or North America (who also tend to be rich in technological, commercial, and social capital) yield the greatest value impact. Additional controls, such as focal-firm performance and alliance experience as well as partner-firm resource measures, do not provide additional explanatory power and thus are left out of subsequent analyses.

5.3.1.2 Transaction-Level Base Models

Further control variables measured at the transaction levels are added to the firm-level base model (‘Control 5’in Table 16). These factors more

[472] See Table 145 of the appendix for models individually testing the influence of each focal firms’ net cashflows provides the best fit, but clearly fails to improve model quality

[473] The effects of public status and patent count are dominated by the pharmaceutical-firm dummy in individual models (see Table 143 in the appendix for details). In terms of model quality, using only *ptrans* even slightly outperforms the model only accounting for *ptype_ph* as well as the one including both. This suggests that collaborations with well-connected biotechnology firms may be as value-enhancing as collaborations with pharmaceutical partners. Given the high correlation between both measures and the prevalence of partner relatedness in prior research, however, the downstream-relatedness variable is used in the reference model for further analyses. All findings are similar, if using social capital instead.

comprehensively accounting for the functional and economic alliance context, but may themselves be endogenous (i.e., reactions to environmental conditions, firm or other transaction characteristics).

Table 17: Selected Transaction-Level Base Models

Variable	Control 10	Control 8	Control 11	Control 12a	Control 12b	Control 4
focalstafflog	-0.0178 ***	-0.0191 ***	-0.0182 ***	-0.0137 **	-0.0127 **	-0.0137 ***
ptype_ph	0.0341 **	0.0315 **	0.0349 **	0.0199	-0.0001	0.0011
pregion_main	0.0432 **	0.0446 **	0.0417 *	0.0324	0.0286	0.0280
f_rnd	0.0127					
Prior		0.0158				
allequity			0.0621 ***			
equityshort				0.1290 ***	0.0441	0.0488 *
equitylong				0.0039		
Jv				-0.0109		
Payin				0.0240 *	0.0072	0.0096
payout				-0.0137		
Value					-0.0001	-0.0001
valuepayin					0.0015 **	0.0014 *
mktretbth						-0.0129 *
intercept	0.0725 *	0.0845 **	0.0765 **	0.0585	0.0595 *	0.0651 *
df	312	312	312	308	309	308
R^2	0.0546	0.0544	0.0814	0.1152	0.2923	0.2971
F	5.559	5.5471	8.0007	6.1431	19.6433	17.6951
AIC	-474.27	-474.23	-483.40	-491.38	-563.14	-564.33

***/**/* indicates significance at 1%/5%/10% levels

Transaction-level controls include the functional focus of collaborative activities, prior partner relations, structural and financial alliance characteristics as well as environmental munificence:

- As predicted by Control 10, collaborative ARs vary with the functional area of collaboration. However, the difference between R&D and non-R&D alliances (1.27%) is not statistically different from zero (model 'Control 10' in Table 17; also see Table 146 of the appendix). In the European biotechnology setting, this is both surprising and encouraging. On one hand, R&D collaboration forms an essential backbone of DBF activities, which should be reflected in the value creation process. On the other hand, the mere distinction of R&D versus non-R&D alliances may be insufficient given the various other dimensions of biotechnology collaboration. This may lead to any effects of R&D focus requiring mediation by other characteristics, such as underlying business models (see 3.3.2.1. p. 140).

- Prior firm relations appear to slightly increase collaborative value, but the effect fails to be significant (model 'Control 8' in Table 17). While this may in part reflect an insufficiently small number of such multi-alliance partner dyads (see Figure 34, p. 191), it also suggests that the trust between already collaborating partners may only be important for certain types of alliances. For instance, additional analyses (see Table 146 in the appendix) showed that repeat alliances more increase ARs in R&D alliances, which would be in line with the notion that trustful collaboration is particularly beneficial under conditions of high information asymmetries. Since this effect does not gain statistical significance, however, Control 8 is not pursued further in the subsequent analyses.
- Control 11 argues that equity-based governance may increase collaborative wealth by mitigating transaction costs. Indeed, equity-based alliances appear to hold greater value-creation potential than purely contractual collaboration (model 'Control 11' in Table 17). Since the *allequity* variable reflects equity investments by either partner and JV formation, this approach does not distinguish between governance and financing considerations.[474] As outbound cash payments (including equity investments in partner firms) have no significant value impact (model 'Control 12a' in Table 17), the main benefit of equity-based collaboration may be for biotech firms to secure funding, which contradicts Control 11.
- More generally, the direction of financial flows refers to both equity investments and other payments to be made or received by the focal firm.[475] Results clearly indicate that, irrespective of the type of payment, incoming cash is perceived highly favorably (model 'Control 12a' in Table 17). This strongly supports Control 12. Furthermore, the extent of

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474 Similarly, formal licenses to technologies and/or drug candidates represents an intermediate governance mechanism between contractual and equity-based governance. As exhibited in Table 147 of the appendix, explicit licences granted by the focal firms (licshort) are associated with significantly increased ARs, whereas inlicensing from partners (liclong) has an (insignificant) adverse effect. However, this effect looses its significance in the presence of more powerful controls, e.g., *allequity*.

475 While logically associated, the direction of equity flows is only marginally (negatively) correlated with the direction of resource flows considered in Hypothesis 6. In further analyses (not reported here), only the correlations between equity investments in the partner (equitylong) and inbound direction (d_inbound) as well as between JV formation (jv) and joint/cross direction (d_joint) are significant. Both correlations are far from overwhelming, though, at 0.1088 and 0.2130, respectively. Regressions correcting for the direction of resource flows (not reported here) did not differ from the presented evidence.

payments to be received by focal firms further increases the announcement ARs. In particular, the nominal *value* of a collaborative agreement is significantly positive for alliance associated with incoming payments (*valuepayin*; model 'Control 12a' in Table 17).[476] This reinforces Control 12 with regard to both the direction and the magnitude of financial flows. Collaboration providing financing or generating income yield higher ARs for focal DBFs, the extent of which is roughly proportional to the incoming financial means.

- In support Control 4, environmental munificence (i.e., capital-market conditions) affect collaborative value creation. In particular, the 200-day returns on the self-constructed DBF stock index (mktretbt; model 'Control 4' in Table 17) decrease announcement ARs.[477] Environmental munificence thus may lower the substantive or signaling value of collaborative announcements (e.g., due to better alternative means of financing). Alternatively, the market may consider the higher compensation DBFs may receive during high-return periods [cf. (Lerner et al. 2003)] insufficient.

In summary, analyses of the transaction-level controls found that they affect value creation. In particular, the inflow of equity and other financial payments significantly increases collaborative value. Environmental conditions, as implied in DBF stock returns preceding alliance announcements, are negatively related to ARs. The functional focus of collaboration and the existence of prior ties between partners have no direct value impact. Table 149 of the appendix summarizes the evidence regarding control factors.

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476 Controlling for the potential bias due to selective reporting of nominal alliance values does not affect the robustness of these findings. While evidence (Table 148 of the appendix) suggests that the mere fact that the transaction value is being reported (valuereport) may have a significant effect *valuereport* becomes insignificant (and even slightly negative) in the presence of *value*. That is, the positive impact in ARs is dependent on the amount of intra-alliance payments rather than on them being reported.

477 As (Park and Mezias 2005) fail to observe a significant association of prior stock returns to announcement ARs after accounting for high and low-munificence periods (see subsection 3.2.1.4, especially FN 238), non-linearity may be a concern. However, a graphical inspection of the relationship between *mktretbt* and AR (not reported here) did not provide any indications thereof.

Using a broader stock index yields similar results, but is less robust to the presence of powerful controls, such as transaction *value*. (see Table 141 in the appendix for details).

5.3.2 Models Testing for Hypothesized Effects

The present section addresses the valuation impact related to the three main sets of hypotheses: Biotechnology-specific transaction characteristics (5.3.2.1), compensation structures and contractual provisions (5.3.2.2) as well as environmental and firm dynamics (5.3.2.3).[478]

5.3.2.1 Biotechnology-Specific Transaction Characteristics

Hypotheses 4 to 6 posit that additional transaction characteristics may help explain collaborative value creation specifically for DBFs. This argument relates to three dimensions, alliance stage, business model, and the direction of resource transfers. The corresponding variables as well as their dual and multiple interaction terms were sequentially added to a base model comprising the relevant industry and firm variables as well as a dummy for R&D being the functional objective of collaboration. The latter was included in the analysis, since it is the only dimension of the alliance 'content' addressed in prior research. While insignificant in isolation (model 'Control 10'), it may thus combine with the other transaction dimensions to provide a detailed picture of DBF-specific alliance value. Table 18 summarizes the estimation results.[479]

[478] Some results of these analyses were presented at European Health Management Association Conference (June 29th, 2006, Title: The Value of Collaborative Entrepreneurship) and the 6th European Conference on Health Economics (July 7th, 2006; Title: Value of Treatment – Results of an Event Study on the Formation of Alliances in the European Biotechnology Industry). The author would like to thank conference participants for helpful comments. All remaining errors and omissions are solely the author's responsibility.

[479] Table 150 to Table 153 of the appendix present the extensive model variations, such as models addressing different business models or directions of resource transfer. These models were pivotal in developing the more complex models presented in Table 18.

Table 18: Selected Transaction Context Regression Models (Hypotheses 4-6)

Variable	Control 10	Hypotheses (Main Effects)	Hypotheses (Interaction)	Hypotheses (Three-way)	Hypotheses (Four-way)	Hypotheses (Compensat.)
focalstafflog	-0.0178 ***	-0.0174 ***	-0.0195 ***	-0.0189 ***	-0.0185 ***	-0.0143 ***
ptype_ph	0.0341 **	0.0262 *	0.0298 *	0.0287 *	0.0298 *	-0.0013
pregion_main	0.0432 **	0.0447 **	0.0389 *	0.0387 *	0.0384 *	0.0290
f_rnd	0.0127	0.0226	-0.0317	0.0063	0.0047	0.0632
exploitation		0.0179	-0.0529	-0.0206	-0.0074	0.0018
m_drug		0.0277 **	-0.0110	0.0753	0.0682	-0.0074
d_outbound		0.0243 *	-0.0556 *	-0.0060	-0.0032	0.0104
rndexploit			0.0513	0.0248	0.0138	0.0160
drugexploit			0.0373	-0.0086	-0.0356	-0.0326
drugout			0.0610 **	-0.2033 *	0.0451	0.0183
drugrnd			-0.0072	-0.0961	-0.0811	-0.0703
exploitout			0.0560 *	0.0090	-0.0101	-0.0168
rndout			0.0561	-0.0015	0.0022	0.0349
drugexploitout				0.1972 **		
drugexploitrnd				-0.0189		
drugoutrnd				0.2661 **		
rndexploitout				-0.0228		
exploit4way					0.2059 ***	0.0817
equityshort						0.0315
payin						0.0001
value						-0.0001
valuepayin						0.0013 *
intercept	0.0725 *	0.0353	0.1218 **	0.0856	0.0818	0.066
df	312	309	303	299	302	298
R^2	0.0546	0.0717	0.1045	0.1215	0.1270	0.2862
F	5.559	4.4846	3.8369	3.5701	4.2829	8.0384
AIC	-474.27	-477.12	-482.76	-485.03	-489.86	-549.91

***/**/* indicates significance at 1%/5%/10% levels

Findings regarding the three hypothesized effects differ to some extent:

- Regressions considering alliance stage variables show that is has only limited influence. In particular, its 'main' effect on ARs is not significant in isolation or when together with the alliance's functional focus (model 'Main' in Table 18). This finding is consistent across different definitions of alliance stages.[480] At best, exploitation alliances appears to

[480] In addition to the distinction of exploration and exploitation [following (Rothaermel and Deeds 2004)], a three category definition (i.e., research, preclinic development to clinical phase II, and clinical phase III to commercialization) as well as a multi-category approach (each stage separately) were used. The only significant effect was observed for clinical phase III projects, which shows significantly higher ARs than other stages. Due to the relatively small size of this subgroup (N=5), however, the broader binary definition was

be perceived marginally more favorably than explorative collaboration. While the exploitation dummy itself remains insignificant in all specifications, its 'two-way' interaction with *d_outbound*, i.e., outbound direction of resource transfer, suggests that the alliance stage may not be entirely negligible (model 'Interaction' in Table 18). On a stand-alone basis, however, the data does not provide support to the claim of exploitation alliances being systematically more valuable than exploration alliances (Hypothesis 4).

- The business model underlying a collaboration substantially affects collaborative value. In the model including only the main effects, the dummy for alliances targeting drug discovery has a significantly positive coefficient of 0.0277. Drug discovery collaboration thus on average yields 2.77% higher ARs than other business models.[481] The evidence thus broadly supports Hypothesis 5. Further analysis (model 'Interaction' in Table 18) shows that this effect arises from *m_drug* interacting with *d_outbound* . That is, alliances capitalizing on focal firms' proprietary drug-discovery projects are by far more valuable than other types of collaboration (including inbound drug alliances and outbound technology or service alliances). Conversely, R&D on drug discovery projects

adopted for further analyses. For validation purposes, most analyses were rerun using late-stage collaboration (clinical phase III to commercialization) instead of exploitation (clinical phase I to commercialization), without producing substantially different results.

481 In individual regressions, drug discovery (m_drug) and platform technology (m_technology) business models are associated with significantly larger and smaller AR, respectively (see Table 150 of the appendix). In combined models, these effects maintain their direction, but the reduced distance to the base category (i.e., all other business models) leads to them becoming insignificant. Using *m_drug* and *m_technology* separately, turns the respectively other into a part of the base category. The analysis presented in Table 18 and further analyses in the main text focus on the valuation impact of drug-discovery alliances. They do so for two reasons: On the one hand, Hausman tests reflected that neglecting the effect *m_drug* would induce an omitted variable bias, whereas collapsing *m_technology* into the base category does not. Second, the individual model for *m_drug* provides a better model fit than the corresponding model for *m_technology*, suggesting that this effect may be more pertinent. In fact, rerunning subsequent analyses with *m_technology* does not improve model fit and m_technology remains insignificant.

or the stage of drug-discovery projects by themselves do not raise collaborative value.[482]

- The direction of resource transfers has an impact on abnormal returns similar to that of the drug-discovery business model. Without considering its interrelations with other transaction characteristics, it has a significantly positive effect of announcement ARs. This supports Hypothesis 6, since outbound drug-discovery alliances provide greater value than either inbound or joint collaboration. In addition to its significant interaction with the drug-discovery dummy (see above), outbound resource transfer also is more valuable if referring to exploitation-stage alliances (i.e., positive and significant interaction term in 'Interaction' model of Table 18).[483] At the same time, the main effect of d_outbound turns (significantly) negative in the presence of both interaction terms. This suggests that the mediating effects of the drug-discovery business model and the exploitation stage may not be additive. This suggests that the value impact of specific alliance constellations may depend on the interplay of multiple alliance dimensions.

Of the four possible three-way interaction terms, only the two involving outbound drug discovery and either exploitation stage (drugexploitout) or R&D (drugoutrnd) exert a significantly positive influence on announcement ARs (see model 'Three-Way' in Table 18). This evidence extends the above finding that outbound drug discovery alliances generally yield high AR. More particularly, capitalizing on proprietary drug candidates creates the greatest value for DBFs, when these projects are in clinical or post-clinical stages. Alternatively, collaborative R&D on proprietary drug candidates may be valuable, even before these drugs enter clinical trials. Yet, the most valuable agreements both are exploitation alliances and involve further joint development.[484] These alliances, identified by the interaction

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[482] These and other insignificant interaction terms are shown here to provide a complete overview of the different (potential) effects. Dropping them generally increases model quality. See Table 153 of the appendix for examples.

[483] This evidence is robust to the omission of development stage and/or business model control variables. As shown in Table 152 of the appendix, the direction dummies remain insiginificant without these controls. Outbound alliances yield higher than joint/cross orientation, when controlling for drug-discovery business models, it looses its significance vis-à-vis the entirety of other directions, i.e., when joint/cross and inbound are collapsed. While the interaction effect of *m_drug* and *d_outbound* can only be unbiasedly estimated for the model containing both main effects, it is stable when the late-stage dummy and its interaction with *m_drug* are dropped.

[484] As the two-way interaction of outbound drug discovery becomes significantly negative with the inclusion of all three-way interaction terms (in a magnitude

of all four alliance dimensions (exploit4way; model 'Four-Way' in Table 18).[485]

In spite of its high coefficient value, the four-way interaction eventually becomes insignificant, when controlling for financial inflows, i.e., incoming equity investments, other payments, and their nominal value (model 'Compensation' in Table 18). The alliances' strategic context and financial implications, particularly the magnitude of receivable payments, thus may transport much of the same information. This suggests that the direction and magnitude of inter-partner payments may adequately reflect the strategic context characterized by the four above dimensions.[486]

The included control variables maintain their effects across most model specifications.[487] This suggests that above-average returns may not only be linked to the hypothesized transaction characteristics. More generally, smaller DBFs continually profit more strongly from collaborating, in particular when linking up with U.S. or European pharmaceutical partners.

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similar to either of the significantly positive effects), the source of the observed variation in ARs may reside in the simultaneity of the four characteristics.

This simultaneity also implies that pure commercialization alliances (i.e., outbound drug exploitation without further R&D) yield lower wealth gains. This may suggest that firms may be penalized for giving up the potential gains from independent commercialization once drugs have actually reached the market.

485 As all 52 outbound drug discovery alliances are either in exploitation stage (15) or involve R&D activities (29) or both (8), regressions using the fourway interaction jointly with all variables, two-, and three-way interactions would violate the imperfect collinearity condition. Consequently, separate regression were run omitting one of the three-way interactions at a time (Table 152 of the appendix). Results indicate that outbound drug R&D in the exploration stage is also value-enhancing. Conversely, non-R&D exploitation of drug candidates tends to be less valuable.

486 Controlling for intra-alliance compensation and its nominal value allows to interpret all other alliance characteristics as being the markets assessment relative to these financial implications. Consequently, insignificant effects imply that the highly positive value impact of *valuepayin* is at least partially due to specific collaborative context. Indeed, the two alliances paying focal firms the highest amounts (€320m and € 500m, respectively) are both characterized by the four-way interaction *exploit4way*.

487 When controlling for financial alliance implications, the partner-specific controls (*ptype_ph* and *pregion_main*) become insignificant. This is consistent with the corresponding control models (see subsection 5.3.1.2) and may indicate that pharmaceutical and large-market firms are more likely to compensate DBFs as part of collaborative ventures. Correlations (not reported here) support this argument.

Multiple lower-profile alliances thus may allow firms sequentially realize collaborative value, (e.g., to accumulate the resources necessary for moving into riskier and potentially more valuable activities).[488]

In summary, DBFs may maximize alliance gains by pursuing specific high-value alliances. In particular, the analysis furthered three biotechnology-specific insights into collaborative value creation:

- Drug-discovery alliances and outbound transfer of such resources generate the greatest value impact. This indicates that DBFs may profit the most by pursuing a 'high-risk, high-reward' business model and collaboratively leveraging promising drug candidates.
- Outbound drug-discovery alliances may be further augmented by collaborating in later (exploitation) stages and including further R&D activities. Given that these factors fail to be independently significant, their value potential primarily results from moderating the primary business-model and resource-transfer effects.
- The insignificance of all transaction characteristics in the presence of controls for financial compensation indicates that the two aspects are interlinked. Most likely, strategically valuable alliances (e.g., outbound, exploitation-stage, drug-discovery alliances with further R&D) appears to be associated with greater incoming cash flows.

5.3.2.2 Compensation Structure and Contractual Provisions

As outlined in subsection 3.3.2.2, hypotheses 7-9 propose that contract constituents may significantly affect the value impact of corporate alliances. Specifically, this related to three aspects: The structure of financial payments, limited contract duration, and explicit contractual flexibilities. Table 19 exhibits the most relevant models.

Compensation Structure

While the direction and value of intra-alliance payments reflect the aggregate financial impact of a given transaction, the structure of these payments represents the extent of risk transferred between collaborating parties and may hold important incentive effects (Hypothesis 7). Distinguishing

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[488] Specifically, the average AR for all functional areas, business models, development stages, and directions are positive, although in some cases only marginally different from zero. For instance, outbound service provision alliances in the exploration stage (e.g., target identification, drug screening) yield a mean two-day AR of 3.67% (median=2.24%), clearly above the overall average of 2.81%. Conversely, technology provision alliances experience close to zero returns (e.g., -0.09% of outbound transactions).

the guaranteed, milestone and royalty payments reported in the alliance announcements as well as their concurrent use yields several interesting findings:

- Controlling for standard firm-level variables (model 'Compensation 1' in Table 19), guaranteed incoming payments (guarantlong) appear to be positively valued, whereas no other compensation component has a significant primary effect. That is, alliances including guaranteed payments yield higher ARs regardless of the other compensation constituents. Additionally, transactions combining receivable milestone and royalty payments (mileroyallong) have the proposed significantly positive effect on value creation.[489]

At first sight, this evidence is contradictory. On the one hand, the guaranteed-payment effect indicates that firms may profit from immediately capitalizing on internal skills and resources. On the other hand, the milestone-royalty interaction suggests that DBFs may particularly benefit from collaboration, in which they maintain a great deal of upside potential.[490] This interpretation is consistent with the evidence presented by (Higgins 2006) for pharmaceutical firms, who observes guaranteed payments not having an effect, whereas milestone and royalty payments are associated with increased value creation.[491]

489 Including only the main effects finds both receivable milestone and royalty payments to be insignificant. This accounts for, the mere occurrence of these payment types, regardless of the overall payment structure, i.e., other payment types used concurrently. The full model, including all two- and/or three-way interaction terms corrects for these interdependencies leaving only the singular use of a given payment type as reflected in the main effect. Evidence is robust to the inclusion of biotechnology-specific transaction characteristics(see Table 154 of the appendix).

490 Both effects combine in transactions involving a combination of guaranteed, milestone, and royalty payments, which exhibit great AR (10.07% on average). At the same time, simultaneity of all three compensation constituents does not significantly increase value creation. The corresponding three-way interaction term fails to gain significance when correcting for the main effects of guaranteed, milestone, and royalty payments. It is excluded, since it would violate the imperfect collinearity assumption (due to small numbers of transactions exhibiting certain two-way interaction).

491 However, (Higgins 2006) does not consider the simultaneous use (i.e., interaction) of guaranteed, milestone, and royalty payments. In multivariate regressions, only the effect of milestone payments persists, which may suggest that pharmaceutical firms benefit from gaining fully proprietary commercialization rights. In contrast, biotechnology firms profit most from receiving both milestone and royalty payments.

- While this analysis considered compensation structures relative to the base case of no payment information being included in the announcement text, these results may be affected by the signal associated with firms reporting compensation structures.[492] Controlling for payments being reported (model 'Compensation 2' in Table 19), guaranteed payments exhibit no significant value impact. This indicates that guaranteed money generally may be an important aspect in cash-generating alliances, but generates no additional value relative to the intra-group average.[493] Conversely, the milestone-royalty interaction remains significant against this higher benchmark. Maintaining upside potential and aligning partner interests thus may be independent from the general payment effect.[494] Moreover, combinations of milestone and royalty payments may reflect a greater magnitude of inter-partner payments. This is in line with the milestone-royalty interaction becoming insignificant if controlling for the nominal value of incoming payments (valuepayin).

In brief, differences in the payment schedule may be of relevance with regard to collaborative value creation. In particular, guaranteed payments may be valuable but standard practices. More importantly, alliances combining milestones and royalties provide firms may allow firms to participate in the projects' upside potential and reduce agency conflicts, which supports Hypothesis 7.

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492 Similar to the case of transaction value (see subsection 5.3.1.2, especially FN 476), any such assessment represents a joint hypothesis test of information availability and the specific content being jointly significant. The *payin* dummy included in subsequent models accounts for selective reporting, leaving the compensation constituents net of this effect.

493 The statistical significance of this effect may also be reduced by the relatively small number of alliances involving only guaranteed payments (9). Conversely, 40 of 78 transactions including guaranteed payments also entail milestone and royalty payments.

494 Note that the relationship between compensation structure and transaction value is not purely deterministic. In particular, the nominal value of an alliance does not include possible royalty payments, since these are usually not quantified. Consequently, the milestone-royalty interaction does not mechanically imply greater nominal value.

Table 19: Selected Compensation Structure & Contractual Provision Models

Variable	Compen-sation 1	Compen-sation 2	Compen-sation 3	Time Limited	Contract Flexibility	Combined
focalstafflog	-0.0146 **	-0.0125 **	-0.012 **	-0.0121 **	-0.0128 **	-0.0122 **
ptype_ph	0.0145	0.0089	0.0002	0.0018	-0.0007	0.0009
pregion_main	0.0368	0.0294	0.0275	0.0295	0.0280	0.0290
guarantlong	0.0826 **	-0.0009	0.0753			
guarantshort	-0.0481	-0.0382	-0.0300			
milestonelong	-0.0699	-0.0987	-0.0367			
milestoneshort	-0.0095	-0.0641	-0.0497			
royaltylong	-0.0047	-0.0793	-0.0102			
royaltyshort	-0.0006	0.0088	0.0026			
guarmilelong	-0.0019	0.0252	-0.0466			
guarmileshort	0.0150	0.0606	0.0351			
guarroyallong	-0.0539	0.0229	-0.056			
guarroyalshort	0.0534	-0.0004	0.0182			
mileroyallong	0.1144 **	0.1226 **	0.0713			
mileroyalshort	0.0012	0.0469	0.0411			
equityshort		0.1262 ***	0.0337	0.0397	0.0470 *	0.0415
Payin		0.0672	0.0025	0.0056	0.0095	0.0080
Value			-0.0003	-0.0004	-0.0002	-0.0004
Valuepayin			0.0017 **	0.0016 **	0.0016 **	0.0017 **
Timelimit				-0.0855 ***		-0.0895 ***
Time				0.0024 ***		0.0024 ***
Optionality					-0.0227	-0.0268 *
timelimitoption						0.0234
intercept	0.0611	0.0546	0.0567 *	0.0537 *	0.0632 *	0.0590 *
df	301	299	297	307	308	305
R^2	0.0659	0.1136	0.2809	0.3300	0.2952	0.3321
F	2.4858	3.3814	7.4981	18.2951	17.5478	15.2852
AIC	-467.5	-482.2	-546.7	-578.6	-563.5	-577.6

***/**/* indicates significance at 1%/5%/10% levels

Time Limitedness and Contractual Flexibilities

In addition to equity-based governance and the incentive effects of certain payment schemes, contractual provisions may mitigate intra-alliance information asymmetries and thus affect post-formation value evolution. On one hand, limited contract duration is often adopted to align partner incentives (Hypothesis 8). On the other hand, contractual options may be considered one form of contingent control rights (Hypothesis 9). Both provisions allow firms to react to new information on partner and/or project characteristics revealed following alliance formation:

- Alliance duration appears to be significantly related to value creation (model 'Time Limit' in Table 19). As proposed by Hypothesis 8, limited duration (timelimit) results in lower ARs, whereas the duration itself (given that it is limited) substantially increases collaborative value. Consequently, fixed contract duration may have a positive value impact, if the trust and learning benefits of long-term collaboration overcompensate for the agency costs implied in time-limited alliances.[495] As this evidence is insensitive to the inclusion of various control variables, the effect of longer-term collaboration is additive to other potentially duration-related aspects, such as greater financial inflows from partner firms. This provides resounding support for Hypothesis 8.
- Explicit contractual options may also provide flexibilities for collaborative adaptation and affect collaborative value. In contrast to their proposed positive value impact (Hypothesis 9), contractual flexibilities have a negative impact on collaborative value, although this effect is statistically insignificant in isolation (model 'ContrFlex' in Table 19). Controlling for the concurrent time-limitedness of collaboration, the effect of contractual flexibilities becomes statistically significant (model 'Combi' in Table 19).[496] This evidence directly opposing Hypothesis 9 suggests that the use of such contingencies may be linked to uncertainty and potential agency conflicts. In this case, the market may primarily perceive them as signals of inter-partner uncertainty or unfavorable collaborative relations rather than value their substantive merits. Along these lines, (Higgins 2006) finds that the contractual flexibility to terminate an alliance increases the value impact for pharmaceutical firms.

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[495] Note that a model including only the timelimit dummy finds it insignificant (see Table 155 of the appendix for details). That is, on average, the value of limited-duration alliances does not significantly differ from that of not time-bound collaboration. However, this represents the combined effect of time limitedness and the actual duration. Depending on the correction variables used, the two effects offset for contracts running between 33 and 37 months (i.e., alliance contracts exceeding this threshold are associated with increased ARs).

[496] Interestingly, this effect is consistent regardless whether options are granted to focal or partner firms (see Table 156 of the appendix for details). Long options often allow focal firms capitalizing on their internal resources to later regain some property rights (e.g., joint commercialization rights). In this case, the price (i.e., discount) transaction partners require for such optionalities may be excessively high.

The control variables largely remain effective. In particular, focal firm size maintains its negative value impact across all contractual-provision (and compensation-structure) models. Similarly, the extent of receivable payments is positively linked to collaborative value.[497]

To summarize, both time-limitedness and contractual flexibilities are alternative mechanisms to restrict agent behavior.[498] As such, the use of either may reflect the existence of information asymmetries and thus reduce collaborative value. Additionally, the (contractually-fixed) duration of alliance contracts is positively related to collaborative wealth gains.

5.3.2.3 Environmental and Firm-Level Dynamics

The third set of hypotheses (10-12) referred to the effects of environmental dynamics and the focal-firm development on the value of alliance formation. This subsection addresses both issues by including variables accounting for competitive dynamics and environmental uncertainty as well as by conducting a split-sample analysis on further and less developed firms.

Environmental Dynamics
Two types of environmental influences were argued to affect collaborative benefits: Competitive pressure to collaborate in order to avoid being left out of valuable industry networks (Hypothesis 10) and dynamically changing environments that may increase the value of organizational flexibility (Hypothesis 11). Table 20 summarizes the econometric evidence on both issues.

The findings on the proposed effects of environmental dynamics are quite divers:

- The level of activity in the market of interorganizational transactions does not appear to affect collaborative value creation. Regardless of the control models used (i.e., even if only controlling for basic firm-level variables) the corresponding variable *mktactivity* remains insignificant (models ‘Activity’ 1 and 2). The coefficient estimates even tend to be

[497] In models accounting for biotechnology-specific transaction characteristics, the two three-way interactions involving drug discovery, outbound direction, and either late stage or R&D function also maintain their significance.

[498] The effects of time-limitedness and contractual flexibilities are largely, but not fully additive. In particular, their interaction term has a positive sign, but fails to be statistically significant. At the same time, its coefficient is similar in size to the one for contractual options itself, indicating that the marginal value reduction resulting from such provisions may be very small if alliance duration is limited.

negative, which contradicts Hypothesis 10.[499] Consequently, market pressures to form alliances in response to competitors' actions either may not exist or not be valued by the capital market as reducing the risk of focal firms being excluded from relevant network positions. This reinforces the notion that, in the European biotechnology setting, collaborative value primarily arises from commercializing existing technological resources rather than positioning DBFs to participate in further technological developments.

- Stock-market volatility exhibits a consistently negative effect on ARs. Controlling for stock returns (mktretbt), the volatility effect (mktvolbt) is significantly negative and even appears to be stronger than the impact of stock returns, which becomes insignificant while maintaining its negative sign (model 'Main 1' in Table 20).[500] This is in contrast to Hypothesis 11, which predicted a positive value impact of environmental uncertainty. Accounting for the interdependence of stock returns and their volatility (ρ=0.2926, significant at the 1% level; see Table 15, p. 251) renders both main effects significant even in the presence of powerful transaction-level controls (model 'Interact 1' in Table 20). That is, *mktretbt* and *mktvolbt* individually reduce announcement ARs, although their impact is largely non-additive.[501]

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499 Also see Table 157 of the appendix.

500 It should be noted that the relationship between abnormal returns and the market volatility used in the present study may slightly biased. Specifically, the estimation period used in generating abnormal returns coincides with the 200-day window over which the volatility measure is calculated. However, the potential bias is limited to the correlation between the intra-sample index (on which the volatility assessment is based) and the broad market index (Stoxx 600) used in abnormal return estimation. As shown in Table 114 of the appendix, this correlation is statistically significant but small substantively.

501 Specifically, the interaction term (mktretvolbt) has a highly positive coefficient value. It barely fails to gain significance in this specification (p=0.1460). While the direction of environmental effects is quite consistent, their statistical significance varies to some degree with model specification. While neither market returns nor market volatility are significant, if not controlling for their interrelation (model 'Main 2' in Table 20) or a broader set of control variables (results not reported here). Similarly, the interaction effect becomes significant in models more broadly accounting for transaction structures, such as time limitedness. This suggests that neglecting the substantial effect of additional control variables may overshadow the more general effect of environmental dynamics. See Table 158 of the appendix for additional model specifications and results of repeated analyses using normalized values of the measures.

Table 20: Selected Environmental-Dynamics Regression Models

	Market Activity		Market Climate and Uncertainty			
Variable	Model 1	Model 2	Main Effects 1	Main Effects 2	Interaction Effects 1	Interaction Effects 2
focalstafflog	-0.0189 ***	-0.0133 ***	-0.0208 ***	-0.0146 ***	-0.0148 ***	-0.0152 ***
ptype_ph	0.0343 **	0.0004	0.0363 **	0.0021	0.0026	-0.0004
pregion_main	0.0450 **	0.0300	0.0442 **	0.0291	0.0301	0.0320 *
payin		0.0093		0.0114	0.0108	0.0071
value		-0.0001		0.0000	0.0001	0.0002
valuepayin		0.0015 **		0.0014 *	0.0013 *	0.0011
mktactivity	-0.0001	0.0000				
mktretbt			-0.0109	-0.0089	-0.0547 *	-0.0755 **
mktvolbt			-2.9866 *	-1.9697	-3.8035 *	-0.2182
mktretvolbt					2.5242	3.3462 *
d_outbound						0.1296 ***
mktretbtout						0.0115
mktvolbtout						-7.5279 **
intercept	0.0987 *	0.0633	0.1426 ***	0.1003 **	0.1268 ***	0.0672
df	312	309	311	308	307	304
R^2	0.0523	0.2865	0.0676	0.2939	0.2965	0.3063
F	5.3560	19.1306	5.5834	17.444	15.7984	12.6255
AIC	-473.5	-560.6	-477.7	-562.9	-563.1	-564.6

***/**/* indicates significance at 1%/5%/10% levels

As the main evidence so harshly contradicted Hypothesis 11, the specific impact of environmental uncertainty on transactions involving the (outbound) transfer of resources to partner firms was examined. Such alliances may be viewed as exercising the flexibilities associated with existing technological resources. High environmental uncertainty may reduce the value of such transactions, since it is associated with high option values, which in return render option exercise suboptimal.[502] Indeed, the interac-

[502] See (Luehrman 1998) for a vivid discussion and analogy to exercising real options. In alliance-related research, (Folta and Miller 2002) observed that firms less often internalize EJVs under conditions of high environmental uncertainty due to the substantial option value of ongoing collaboration (see subsection 2.4.2.3 for details).

Alternatively, environmental uncertainty may reflect transaction and/or agency costs. Consequently, the finding of stock-market volatility reducing AR might reflect difficulties in valuing partner firm contributions (i.e., information asymmetries) or imply the need for more stringent alliance governtion of the stock-market volatility measure with the outbound-dummy (mktvolbtout) is substantially negative and significant (model 'Interact 2' in Table 20). In line with the option-based logic of Hypothesis 11, the negative value impact of high market volatility thus results from the reduction in strategic flexibility associated with outbound transactions. As the main effect of *mktvolbt* becomes insignificant in the presence of the *mktvolbtout* interaction, environmental uncertainty does not reduce collaborative value for other alliance directions.[503]

While the coefficients of most control variables are relatively stable across the models shown in Table 20, the inclusion of market-dynamics variables leads to two distinct changes in their significance:

- The main effect of outbound resource transfers (d_outbound) becomes highly significant when controlling for its interaction with environmental uncertainty. This also extends to specifications accounting for the specific collaborative context (i.e., including all four transaction dimensions as well as their three- or four-way interactions), whereas all other findings regarding biotechnology-specific transaction characteristics are unaffected.[504] Any kind of transaction capitalizing on existing resources (e.g., including platform technology and service provision) thus is favorably perceived, if environmental uncertainty is moderate.
- When considering environmental dynamics, the extent of financial payments to the focal firm (valuepayin) looses some of its significance. In

ance. Both of these effects, however, should equally apply to in- and outbound transactions.

503 The interation of stock-market climate with the outbound resource transfers (mktretbtout) was included for control purposes. Its insignificance and the significant main effect of mktretbt only indicate that favorable environmental conditions reduce the benefits of all alliances. For instance, easier access to external financing facilitating proprietary activities relative to both collaborative insourcing and outlicensing.

504 See Table 158 in the appendix. Since market volatility is a truncated (i.e., non-negative) variable, the coefficient estimate for the *d_outbound* variable refers to the (unrealistic) extreme case of zero variance and thus overstates its net effect. For instance, at the median level of market volatility (0.8357%), the negative effect of market uncertainty in outbound collaboration exceeds that in other transactions by 6.2909%, leaving a net benefit of 6.6678%. For market volatility levels exceeding 1.7214%, the negative interaction effect even overwhelms the positive main effect of *d_outbound*, leading to a negative net impact of outbound resource transfers. This corresponds to about the 85th centile of the distribution. That is, under conditions of extremely high market uncertainty outbound transactions are associated with lower predicted ARs than inbound or joint/cross collaboration due to the loss-in-flexibility discount.

the fully specified model ('Interact 2' in Table 20), it even becomes insignificant, in spite of a continually high coefficient estimate (0.11% per million Euros compared to 0.15% in the base model). This may suggest that *valuepayin* primarily reflects a residual factor compared to more specific influences, such as the inherent value of outbound alliances.

In summary, environmental uncertainty (proxied by the market-volatility measures) affects collaborative value in ways quite distinct from the general environmental conditions (reflected in the market-return measures).[505] While this supports the general logic of Hypothesis 11, it was incorrectly specified. Environmental does not increase the flexibility value of corporate collaboration, but penalizes firms for giving up existing flexibilities. While this evidence may be specific to the biotechnology setting studied here (e.g., since outbound transactions play a more prominent role than in other contexts), it indicates the need to consider the net impact of an alliance on the portfolio of strategic options available to the focal firm.

Firm Dynamics

The influence of corporate development on collaborative gains is the first hypothesis not linked to specific explanatory variables. While firm age has traditionally been used as a proxy [e.g., (Park and Mezias 2005)], using it as a variable will only allow to reiterate the results observed with regard to firm size (ρ=0.7691 in Table 15; ρ=0.4990 for the logarithmic values of both variables). Additionally, Hypothesis 12 not only argued that firm development had a significant value impact, but also that it moderated the various drivers of collaborative value creation. Since this argument extends to the entirety of observed effects, a split-sample approach was employed to address this issue. Specifically, two subsamples were constructed to reflect further and less developed firms, with transactions being assigned based on their position relative to the sample median number of focal-firm employees (focalstaff).[506]

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505 The observed effects of environmental uncertainty are robust to alternative approximation and controls. Using the 200-day returns on a general market index (Stoxx600) as a proxy for environmental conditions does not affect the direction and/or significance of the market volatility effect. Similarly, using a generic European biotechnology index (Stoxx Biotech All-Share) instead of the self-constructed one does not alter the above conclusions (Results are not reported here, but available from author upon request). Additionally, the evidence is free from endogeneity, since the ARs were calculated using a standard market model rather than being based on the intra-sample index.

506 Note that the segmentation was conducted at the transaction level, i.e., the focal firms' number of employees had to be above/below the median number of employees for all transactions. This approachs accounts for firms developing

On the most general level, the value impact of alliance-formation announcements differs substantially between the two subsamples. As was to be expected based on the significant effect of focalstaff in cross-sectional analyses, the ARs to the further-developed (i.e., larger) subsample are significantly smaller than those to the less-developed (i.e., smaller) subsample. As shown in Table 21, the differences of means and medians are significant at the 1% level using a parametric t-tests and the non-parametric Wilcoxon signed-rank test, respectively.

Table 21: Comparison of Summary Statistics for Firm Development Subsamples

Variable	Large Subsample		Small Subsample		Difference Tests	
	Mean	Median	Mean	Median	t-test	Wilcoxon
focalstaff	913.10	521.50	110.86	113.50	***	***
carMM2	.00890	.00350	.05174	.01806	***	***

***/**/* indicates significance at 1%/5%/10% levels

In order to assess the claim that firm development will moderate the collaborative value creation mechanisms (Hypothesis 12), all models were separately estimated for both subsamples. The results were to a large extent supportive of the hypothesized difference, i.e., indicated that the value drivers for observed for the entire sample more strongly applied to the smaller-firm subsample.[507] To gain a more thorough understanding of the interdependencies of firm development and value creation, the different sets of variables also were combined into larger models. Table 22 presents the estimation results for the entire sample as well as the two subsamples using two such 'combined effects' models.

Evidence for the three sets of hypothesized effects and for several control variables significantly differ between further and less developed firms:

- Biotechnology-specific transaction characteristics exhibit a much more complex pattern of influences than in the combined effects model, i.e.,

over the sampling period. While some firms may always belong to either the smaller or the larger subsample, others may move from one to the other by upscaling or downsizing operations. This is also the substantive reason for not using focal firm age as the primary proxy for firm development. Using focal fim age (i.e., number of days since IPO) as the segmenting variable, however, does not significantly affect the outcomes.

507 The estimation results for models on biotechnology-specific transaction characteristics, contractual provisions, and environmental dynamics are reported in Table 159 of the appendix.

when simultaneously accounting for all potential influences.[508] For the entire sample, two variables are significant: The main effect of outbound resource transfer (d_outbound) and the four-way interaction of all transaction dimensions (exploit4way). Surprisingly, neither effect is significant for either subsample. As both variables exhibit relatively high coefficient estimates across both larger and smaller firms, however, they may represent the smallest common denominator with regard to the collaborative value creation. They imply that, ceteris paribus (e.g., accounting for the influence of environmental volatility on outbound collaboration), European biotechnology firms may generally benefit from bringing proprietary resources into the collaboration. At the same time, they stand to earn even higher ARs, when the outbound alliance relates to a (proprietary) drug-discovery project, is in the exploitation stage (at least clinical phase I), and entails further R&D activities (rather than pure commercialization and/or manufacturing agreements).

The two subsets differ vastly with regard to other transaction characteristics. For larger firms, drug-discovery alliances (m_drug) hold significant value potential, which is, however, offset if such transactions are in the exploitation stage (drugexploit).[509] As these influences are additive to the sizable (albeit insignificant) effect of *exploit4way*, this implies that larger firms may benefit from both in- and outbound exploitation-stage drug-discovery alliances. In contrast, smaller firms only gain in value from transactions drawing on their internal drug-discovery projects. Specifically, they experience a significantly positive effect of outbound drug collaboration (drugout), irrespective of development stage. Moreover, later-stage (exploitation) do not lead to the expected value gains for smaller firms, unless they are the party transferring resources to the partner (exploitout).

These findings suggest that smaller firms are restricted to outbound transactions for earning high collaborative returns, whereas larger firms may also substantially gain from incoming drug targets or candidates.

508 In isolation (Table 159 in the appendix), the positive valuation effects of drug-discovery alliances and alliances transferring focal firm resources to the partner are much stronger and significant only for the smaller-firm subsample. As hypothesized, the four-way interaction term of outbound exploitation-stage drug-discovery alliances with an R&D focus exhibits a similar pattern.

509 Note that these effects are only significant in the reduced model, i.e., excluding the compensation structure variables. This implies that at least some of the effect exploitation-stage drug collaboration has may arise from their more attractive compensation profile. For instance, both long (receivable) and short (payable) deferred payments (i.e., combinations of milestones and royalties) have sizably positive, albeit statistically insignificant effects in the full model.

This reflects exactly the kind of heterogeneous value impact anticipated by Hypothesis 12.

- Contractual provisions significantly affect collaborative value in the combined-effects models. Specifically, the pattern of time-limited collaboration (negative), contract duration (positive), and contractual flexibilities (negative) persists in both specifications. With regard to the limitedness and extent of contract duration, the evidence for the smaller-firm subsample is in line with the overall findings. Coefficient estimates are larger (in absolute terms) than for the overall sample and statistically significant. For the further-developed subsample, these effects are insignificant, although all estimates have the correct sign. Contrary to the evidence on time-limited collaboration, contractual flexibilities are insignificant for both subsamples. While the coefficient value for the small-firm subsample is high (in fact, higher than the significant coefficient for the entire sample), the effect of contractual options is much smaller for further-developed firms. All of these findings point towards contractual provisions having a stronger value impact for less developed firms, who may simply be subject to greater information asymmetries. With regard to time-limitedness and contractual flexibilities, evidence thus supports Hypothesis 12.[510]

  Contrary to the individual model above (see Table 19, p. 270), compensation structure does not significantly affect collaborative value, when simultaneously controlling for the other hypothesized effects. This result is consistent for the entire sample as well as both subsamples and opposes both Hypothesis 7 as well as Hypothesis 12 with regard to compensation structure. Consequently, compensation constituents were dropped in the 'reduced model' without incurring substantial changes in other findings.[511]

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510 These conclusions are also supported by regression models singling out contractual provison effects (Table 160 in the appendix).

511 As discussed in subsection 5.3.2.2, the compensation structure variables already turned insignificant when entering the nominal value of interpartner payments (value). Furthermore, an F-Test on the joint significance of all 12 compensation structure variables included in the full model finds them collectively insignificant (F=0.76, p=0.6948 with df=278).

Differences in the valuation effect of compensation structure for smaller and larger firms were also studied in isolated regression models (see Table 160 of the appendix). While generally supporting the notion of less-developed firms underlying more strongly underlying the purported value creation mechanisms, this analysis is hindered by the lack of sufficient information on compensation structures (i.e., some combinations are unavailable for the small-firm subsample).

- The effects of environmental conditions on collaborative wealth gains are robust to the inclusion of the other hypothesized effects. In particular, environmental munificence (mktretbt) and environmental uncertainty (mktvolbt) are both negatively related to ARs, but subadditive.

While the influence of environmental conditions is quite consistent for both subsamples in terms of their direction, they differ in their magnitude and significance. The main effects of stock-market returns and return-volatility interaction are significant only for the larger-firm subsample. Conversely, the volatility-outbound interaction exhibits substantially larger coefficients for less-developed firms, but is not statistically significant.[512] These findings suggest that the influence of environmental conditions on the collaborative gains may differ with firm size. On one hand, further-developed firms apparently are most affected by general market conditions. In particular, the substantial coefficients of the market climate (marketretbt) and market volatility (mktvolbt) variables reflect access to alternative sources of financing and transaction/agency cost considerations. On the other hand, the option-based reasoning regarding market volatility primarily holds for the less-developed firm subsample. The value of such 'hit-or-miss' investments may decline the most, if they are prematurely exercised (i.e., under conditions of high uncertainty).

Overall, the evidence in Table 22 provides a detailed account of how value creation mechanisms differ with firm development. The explanatory power of the regression models also supports Hypothesis 12, since it is massively higher for less-developed firms. In fact, the hypothesized and control effects explain over 50% of the variation in ARs for this subsample, whereas they outright fail to explain collaborative value creation for further-developed firms.

[512] This effect is significant in separate regression models (i.e., without simultaneously including all other hypothesized effects). Additionally, the main effect of market volatility is significant for the further-developed subsamples in insolated models. This suggests that while larger firms experience adverse effects of environmental uncertainty, these are not limited to outbound transactions (e.g., due to information asymmetries in inbound alliances). See Table 161 in the appendix for details.

Table 22: Split-Sample Regressions (Combined Effects Models)

Panel	Entire Sample		Large-Firm Subsample		Small-Firm Subsample	
Model	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**
focalstafflog	-0.0135 **	-0.0140 ***	-0.0072	-0.0075	-0.0285	-0.0251
ptype_ph	0.0044	0.0008	0.0107	0.0135	0.0082	-0.0083
pregion_main	0.0306	0.0295	0.0227	0.0238	0.0326	0.0353
m_drug	0.075	0.0603	0.0789	0.0841 *	-0.0247	-0.0319
f_rnd	0.0090	0.0101	0.0228	0.0255	0.0126	0.0153
exploitation	0.0006	-0.0029	0.0317	0.0326	-0.1113 *	-0.1135 *
d_outbound	0.1021 *	0.1108 **	0.0751	0.0849	0.0646	0.1129
drugexploit	-0.0731	-0.0523	-0.0811	-0.0850 *	-0.0487	-0.0073
drugout	0.0198	0.0250	0.0040	0.0028	0.0941 *	0.1019 **
drugrnd	-0.0694	-0.0652	-0.0770	-0.0715	0.0034	-0.0087
rndexploit	0.0153	0.0163	0.0028	0.0102	0.0563	0.0711
rndout	0.0071	-0.0015	0.0042	-0.0028	0.0004	-0.0346
exploitout	-0.0125	-0.0174	-0.0445	-0.0408	0.1449 *	0.1172
exploit4way	0.1229 *	0.1047 *	0.0617	0.0599	0.0397	0.0107
equityshort	0.0183	0.0318	0.0355	0.0237	-0.0178	0.001
payin	0.0518	0.0009	0.0322	0.0051	-0.0251	0.0097
value	-0.0004	0.0000	-0.0001	-0.0003	0.0175 **	0.0183 ***
valuepayin	0.0016 *	0.0011	0.0002	0.0005	-0.0162 **	-0.0171 ***
timelimit	-0.0963 ***	-0.0862 ***	-0.0219	-0.0202	-0.1430 ***	-0.1318 ***
time	0.0026 ***	0.0024 ***	0.0003	0.0003	0.0044 ***	0.0041 ***
optionality	-0.0358 **	-0.0349 **	-0.0232	-0.0228	-0.0425	-0.0388
timelimitoption	0.0192	0.0375	-0.0161	-0.0150	0.0284	0.0345
mktretbt	-0.0909 ***	-0.0893 ***	-0.0914 **	-0.0897 **	-0.0659	-0.0474
mktvolbt	-1.5323	-1.6124	-3.4169	-3.0590	-0.1978	0.4990
mktretvolbt	4.2695 **	4.1994 **	4.5494 *	4.4989 **	3.4152	2.4018
mktvolbtout	-5.7773 *	-6.0385 **	-3.1034	-3.8985	-6.9433	-6.9949
guarantlong	0.0340		-0.0197		0.1543	
guarantshort	0.0165		0.0647		-0.0140	
milestonelong	-0.0610		-0.0664		0.0563	
milestoneshort	-0.0261		-0.0774		0.0174	
royaltylong	-0.0642		-0.0155		0.0051	
royaltyshort	-0.0004		0.0117		-0.0078	
guarmilelong	-0.0406		0.0312		-0.0957	
guarmileshort	-0.0178		0.0013		n/a	
guarroyallong	-0.0144		-0.0067		-0.0892	
guarroyalshort	-0.0060		-0.0988		0.1017	
mileroyallong	0.0835		0.0689		-0.0155	
mileroyalshort	0.0609		0.0821		-0.0512	
intercept	0.0731	0.0824	0.0561	0.0494		0.1126
Df	278	290	119	131	121	132
R^2	0.3490	0.3556	-0.1136	-0.0473	0.5049	0.5049
F	5.4588	7.7066	0.5787	0.7271	5.3547	7.1967
AIC	-561.2	-575.0	-332.7	-351.2	-240.5	-248.6

***/**/* indicates significance at 1%/5%/10% levels

Finally, some of the control variables included in the combined-effects models also have stronger effects on the announcement AR for the smaller-firm subsample. While focal firm size (focalstafflog) is insignificant in all subsample regressions, the coefficient estimates for the less-developed subsample exceed those derived for the overall sample, suggesting that some size-based variation may persist within this subsample. The main size-related differences in ARs, however, exist between subsamples.[513] More substantially, the nominal value of financial payments significantly affects ARs (value) for the small-firm subsample. Contrary to the general evidence, its interaction with incoming financial payments (valuepayin) has an adverse effect. This is quite counterintuitive, since it indicates that the impact of financial payments on ARs is lower if small firms stand to receive higher amounts. More generally, it might suggest that the magnitude of payments to be received is not as important for smaller as for larger firms. At the same time, this evidence may be an artifact of the small number of observations reporting the value of incoming payments for the less-developed subsample.[514]

5.3.2.4 Discussion of Cross-Sectional Findings

The preceding analyses have documented various influences, which together determine a fairly large share of the overall variation in ARs. Specifically, eight hypotheses (4-11) were tested by including the corresponding variables in multivariate regression models. These analyses have found support for most of the hypothesized effects. In particular, all three blocks of hypotheses provided significant evidence on collaborative value crea-

513 The effects of alliances with pharmaceutical partners (ptype_ph) and partners from Europe and/or North America (pregion_main) also show some subsample differences. The latter appears stronger for the smaller-firm subsample, although its coefficients are statistically insignificant. This patern persists across individual effects regressions (Table 159 to Table 161 in the appendix). Conversely, the effect *ptype_ph* appears to be higher for larger firms, although the effect is insignificant and ambivalent in individual regressions.

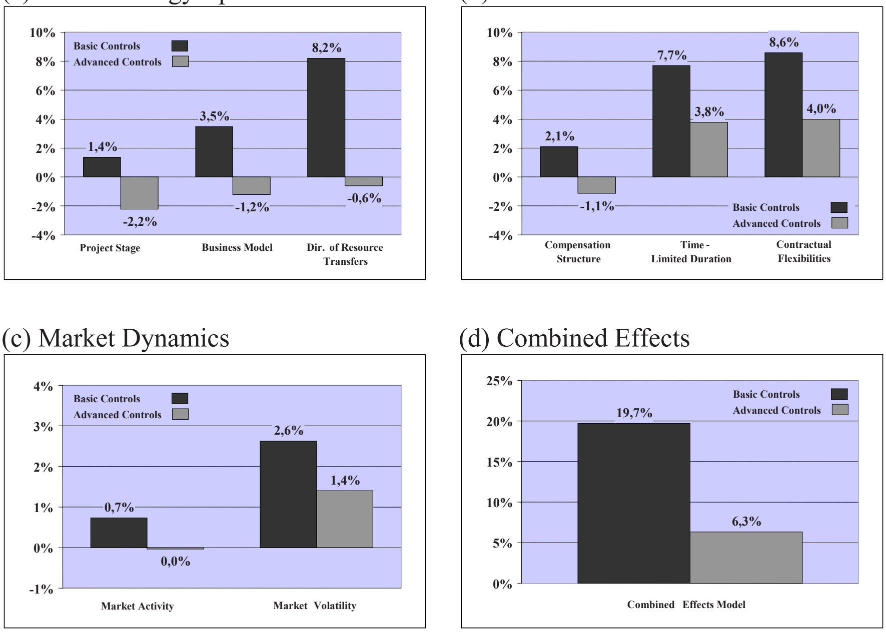
514 Specifically, the two announcements indicating the value of financial payments to the partner firm yield quite high returns (mean carMM2: 6.71% and 25.25%) for the relatively low figures (mean *value*: 2m€ and 20m€, respectively). In contrast, the 21 such announcements, in which the focal firm stands to receive the specified amount, on average yield even higher AR (mean: 20.85%), but also report much higher nominal values (mean: 82.73m€). As a result, the relative value impact per unit of payment is substantially higher for transactions, in which focal firms make payments to their partners.

tion.[515] The specific collaborative context, contractual structures, and environmental dynamics all significantly affect announcement ARs, in excess of the influences previously demonstrated by other studies.

While all hypothesized sources of collaborative value creation thus may have their merits, their explanatory power varies substantially. As an overview, Figure 38 provides an compares the adjusted R^2 measures for the best performing models on each hypothesis as well the combined-effects model relative to base models accounting for standard firm-level (left column) and advanced transaction-level controls (right column).

Figure 38: Summary of Model Quality (Adjusted R^2 Measure)

(a) Biotechnology-Specific Factors (b) Contractual Constituents



Data Source: Own Analysis

Using the two types of base models reported in Figure 38 as reference cases, allows to draw some general conclusions from the pooled cross-sectional analysis:

- All three sets of hypothesized effects increase in explanatory power relative to the simple, firm-level base model (left columns). For the biotechnology-specific alliance context, the interplay of all four transaction

515 A more extensive summary of findings is given in subchapter 6.1, accounting for the assumption tests and robustness checks in the following sections.

dimensions produces the greatest level of additional insight.[516] Among contractual considerations, both time-limited duration and contractual flexibilities explain a substantial share of the data variance in excess of the base model. Finally, stock-market volatility provides a moderate increase in explanatory power.[517]

- More comprehensively controlling for transaction characteristics, such as inter-firm payments and equity-investments (right columns), substantially reduces the explanatory benefits of the hypothesized variables. Specifically, the specific alliance characteristics do not improve model fit relative to this benchmark.[518] As discussed in subsection 5.3.2.1, this may imply that the inherent differences in collaborative value between different types of biotechnology alliances are adequately reflected in their financial implications. Among the contractual provisions, only the compensation structure fails to increase explanatory power. This suggests that the effects of time-limitedness and contractual options are additive to those of general transaction characteristics. Finally, market volatility (including its interaction effects) also increases model fit relative to the transaction-level base model.

While this evidence provides a first glimpse at the empirical support for the hypothesized effects and their relative magnitude, the validity of these findings still needs to be assessed. To ensure that inference is free from statistical distortions, a variety of model assumptions were tested and the regression results were subjected to extensive robustness checks.

5.3.3 Assumption Testing and Model Robustness

As outlined in subsection 4.5.1.1, several core assumptions underlie the OLS regression approach used in the preceding analyses. Subsection 5.3.3.1 presents the evidence furthered by the formal (and graphical) testing procedures applied in this regard. All tests were performed for seven different estimation models, which consider the different controls and hy-

[516] Note that the 'Direction of Resource Transfers' model in Figure 38 comprises the main effects of the other three dimensions as well as the variaous interaction effects.

[517] Note that the 'Market Volatility' model in Figure 38 also includes the main effect of stock-market returns, outbound direction of resource transfers as well as their interaction effects.

[518] Note that any reduction in the adjusted R^2 due to the inclusion of variables testing for hypothesized effects is not shown in Figure 38 for graphical reasons. Such reductions are generally small and result exclusively from the R^2 adjustment for the number of explanatory variables included in the model.

pothesized effects separately as well as in conjunction.[519] Later subsections (5.3.3.2 and 5.3.3.3) address the impact of controlling for the documented shortcomings on the estimation results.

5.3.3.1 Results of Regression Diagnostics

The main diagnostic tests used in the pooled cross-sectional framework relate to the homoskedasticity assumption and the relevance of outliers. Additionally, tests were used to assess autocorrelation and collinearity.

Assessment of Heteroskedasticity
Both formal and graphical tests reject the assumption of homoskedasticity:

The composite test for heteroskedasticity [(Breusch and Pagan 1979)] rejected the null hypothesis of constant variance (i.e., homoskedasticity) at almost certainty level for all models analyzed. Specifically, chi^2 values range from 139.91 to 539.94 and are all significant at the 0.01% level. This indicates that models are generally subject to heteroskedasticity, which may arise from certain variables (e.g., due to model misspecification) or affect the model as a whole.

Consequently, each variable was individually tested for heteroskedasticity. The test on the individual variable level [(Szroeter 1979)] rejected the hypothesized homoskedasticity for numerous explanatory variables. Notable exceptions are only the capital-market variables (i.e. stock market returns and their volatility) which are quite consistently free from heteroskedastic effects. Table 23 presents the test results for all variables included in the combined-effects model, which failed the Breusch-Pagan aggregate test with a chi^2 value of 311.84.[520]

In addition to these formal tests, scatter plots matching (standardized) estimation residuals and predicted abnormal returns were analyzed, but

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[519] In addition to the two control models used as reference cases in Figure 38, hypothesized models related to biotech-specific alliance characteristics (i.e., integrating all four dimensions), compensation structure, other contractual provisions (i.e., combining time limitedness and contractual optionalities), and environmental dynamics as well a model combining all these effects (with the exception of comensation structures, which have no significant effect in the presence of more extensive controls). Market activitiy is not considered further, since its hypothesized effect was resoundingly rejected.

[520] Table 162 in the appendix provides the test results for the six sub-models. Note that the compensation structure variables are not included in the combined model, since their effects become moot when controlling for nominal transaction value (see subsection 5.3.2.2) and their inclusion substantially reduces the fit of the combined-effects model.

only provided limited indication of higher residual variance for higher levels of AR.[521] On the individual variable level, however, graphical evidence convincingly emphasized differing variance of the residuals for several explanatory variables. Figure 39 provides an example plotting the average standardized residuals per event (sresAVG, averaged over the seven different estimation models[522]) against the focal firm size measure (i.e., focalstafflog, the logged number of employees). The variation in residuals quite obviously is higher for smaller firm sizes, rejecting the assumption of constant error variance. This conclusion persists even after tossing out observations with very high standardized residuals (>3 in absolute terms), indicating that it is not driven by outliers.

Table 23: Test Results for Heteroskedasticity in Combined Effects

Controls		**Alliance Characteristics**		**Contractual Provisions / Environmental Dynamics**	
Variable	**Chi²**	**Variable**	**Chi²**	**Variable**	**Chi²**
focalstafflog	20.58 ***	d_outbound	5.20 **	timelimit	10.11 ***
ptype_ph	2.76 *	m_drug	15.84 ***	Time	15.92 ***
Pregion_main	4.93 **	f_rnd	0.23	optionality	2.02
equityshort	96.24 ***	exploitation	3.31 *	timelimitoption	24.32 ***
Payin	19.13 ***	drugexploit	22.38 ***	mktvolbt	1.50
Value	92.24 ***	drugout	68.95 ***	mktretvolbt	0.80
valuepayin	129.20 ***	drugrnd	6.11 **	mktvolbtout	0.19
		rndexploit	0.87		
		rndout	15.94 ***		
		exploitout	3.05 *		
		exploit4way	34.84 ***		

***/**/* indicates significance at 1%/5%/10% levels

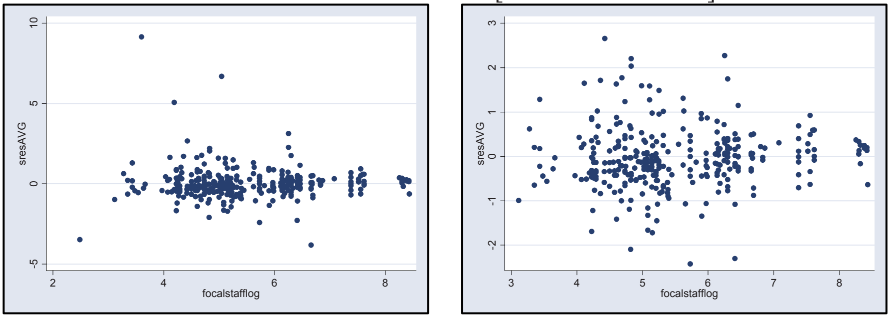
[521] Similar analyses (not reported) were conducted using raw (i.e., not standardized) estimation residuals and actual (instead of predicted) abnormal returns without yielding different insights with regard to heteroskedasticity.

[522] The averaged statistics are used to reduce the scope of evidence to be presented and to document the robustness of the evidence. Findings were consistent for all (sub-)models.

Figure 39: Example of Residual Scatter Plots Indicating Heteroskedasticity

(a) Full Sample

(b) Reduced Sample [with |sresAVG |<3]



Data Source: Own Analysis

Overall, the evidence thus clearly demonstrates that the error variance is inconstant and varies with the levels of several variables, including focal firm size, partner equity investments, transaction value, and various transaction context variables as well as their interaction terms. This suggests that the significance tests for these parameter estimates may be biased by heteroskedasticity. As a result, the analysis was repeated using estimators robust to inconstant error variance (see subsection 5.3.3.2 for the results).

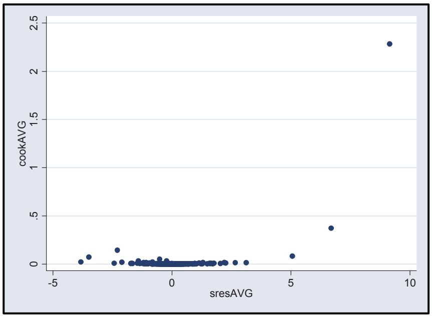
Identification of Outliers

Standardized residuals and Cook's Distance were calculated for each observation. Figure 40 exhibits a scatter plot matching both measures (averaged across the seven estimation models). A fairly great number of observations diverge substantially from their predicted values. For instance, between 9 and 20 observations had standardized residuals greater than 2 in absolute terms, depending on the estimation model. 5 to 7 observations had absolute values greater than 3. Comparably few observations appear to strongly influence estimation outcomes. In particular, only two observations had Cook's Distance statistics above 1 for any model. As proposed in subsection 4.5.1.1, all observations having standardized residuals greater than +3 or smaller than –3 and/or Cook's Distances larger than 1 were reviewed to control for errors in the raw data, event coding, or estimation.[523]

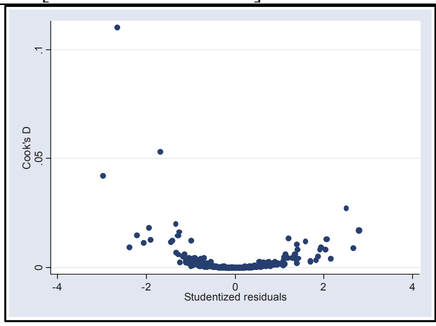
[523] With one single exception, no such shortcoming could be identified and abnormal returns could be validated, irrespective of their magnitude. The exclusion of the only inconsistent observation, a confounding event not initially corrected for, does not change the above estimation results. Table 165 of the appendix further discusses the observations considered as outliers.

Figure 40: Scatter Plots of Standardized Residuals and Cook's Distance

(a) Full Sample



(b) Reduced Sample
[with |sresAVG |<3]



Data Source: Own Analysis

Given the lack of evidence that 'outlying 'or influential observations may be flawed or unduly distort the results of the analysis, no adjustments appear to be mandated. At the same time, the relatively large heterogeneity in value creation (e.g., indicated by the large number of high-residual observations) suggests that results may be sensitive to transactions resulting in particularly positive or negative announcement returns. To be prudent, the present study controlled for differences in the value determinants when omitting some 'outlying' observations.

Tests for Collinerarity and Autocorrelation

In addition to the two main diagnostics above, a battery of other tests was performed. The results of tests for multicollinearity and autocorrelation deserve specific mention:

- The variance inflation factors (VIF) calculated for each explanatory variable indicated some collinearity problems, when variables were used jointly with their interaction terms. In particular, this affects the nominal transaction value (value) and its interaction with incoming payments (payin, valuepayin) as well as market dynamics variables (mktretbt, mktvolbt) and their interactions with each other and with outbound direction of resource transfers (d_outbound, mktretvolbt, mktvolbtout, mktretbtout). To a lesser extent, the drug-discovery business model dummy (m_drug) and its interaction with a collaborative focus on R&D activities (f_rnd, drugrnd) are subject to this problem.[524] Since the col-

[524] All these variables exhibit VIFs larger than 10. (Gujarati 2003) proposes a VIF cut-off value of 10, since it indicates that 90% of the variation in one

linearity results from interaction terms, however, it does not fundamentally compromise the overall estimation results. In this context, high VIF scores reflect the difficulty of consistently attributing valuation effects to main and mediating or moderating effects.

- Estimation results were tested for autocorrelation given the prevalence of multiple observations per firm. The Durbin-Watson test statistic of 1.7489 indicates some positive correlation among the regression residuals.[525] To ensure that this does not result from the exclusion of time-dependent variables, the standardized residuals were plotted against calendar time (Figure 41[526]). While the dispersion of residuals appears to widen over time, this coincides with a substantial increase in the number of observations. Also, there is no apparent pattern and residuals remain evenly scattered around zero.

While there thus is some evidence of collinearity and autocorrelation, it remains weak and does not necessitate explicit correction. Another possible source of cross-sectional bias, firm-specific effects, will be separately considered in subchapter 5.4.

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variable can be explained as a linear combination of the concurrently used explanatory variables. Contrarily, (Fox 1991) refers to VIF values above 5 (auxiliary R^2 ~80%) as problematic.

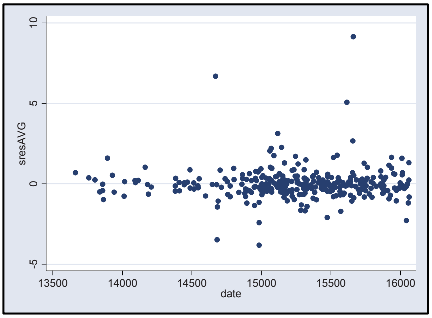
To document that the collinearity problem is limited to the interaction effects, regressions were constructed including only the main effects of these variables. All VIF values were well below either threshold. See Table 164 of the appendix for details.

525 The Durbin-Watson test value of 1.7489 is for the combined-effects model. Overall, one model (contractual provisions) failed the Durbin-Watson test at the 5% level of signifcance. Another (market dynamics) failed at the 10% significance level. All others were free from autocorrelation. This analysis was limited by some observations occurring on the same date. To analyze serial dependence, these observations were randomly ordered. Consequently, some autocorrelation may result from correlation among events. Indeed, considering only the first observation on a given day improves the Durbin-Watson statistic to 1.8994.

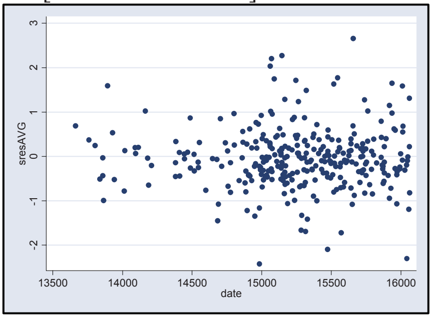
526 Note that STATA™ represents dates as the number of days since 01/01/1960.

Figure 41: Scatter Plots of Standardized Residuals over Calendar Time

(a) Full Sample



(b) Reduced Sample
[with |sresAVG|<3]



Source: Own Results

5.3.3.2 *Estimation with Heteroskedasticity-Consistent Standard Errors*

Given the pervasive effect of heteroskedasticity documented in the previous subsection, all main analyses were repeated using the heteroskedasticity-consistent estimators proposed by (White 1980). Table 24 presents the estimation results regarding biotechnology-specific alliance characteristics (Hypotheses 4-6), contractual provisions (Hypotheses 8-9), and market dynamics (Hypothesis 11).[527]

Accounting for heteroskedasticity in cross-sectional regressions requires some reassessment of the documented effects:

- Heteroskedasticity-correction has a profound effect on the regression results for the individual ‘Alliance Characteristics’ model analyzing the biotechnology-specific transaction characteristics. Specifically, the four-way interaction term for outbound, exploitation-stage drug-discovery collaboration with further R&D (exploit4way) activities looses its significance, whereas the main effect of drug-discovery collaboration

[527] Models considering compensation structures (Hypothesis 7) and market activity (Hypothesis 10) were also estimated but yielded no results after controlling for heteroskedasticity. All in all, this implies that neither has a substantial impact. With regard to compensation structures, this is in contrast to the results obtained without accounting for heteroskedastic effects. This may, however, be an artefact resulting from the relatively small number of transaction reporting compensation structures. The estimation results are shown in Table 163 of the appendix.

(m_drug) becomes significant. These changes in parameter significance suggest that drug-discovery alliance in general yield greater ARs and that this effect is only partially moderated by the other three transaction dimensions.

Comprehensively controlling for the effects of the other hypothesized influences, provides a picture more in line with simple OLS results [‘Combined Effects’ model in Table 24]. In particular, *exploit4way* remains significant (albeit only at the 10% level). In addition, an outbound direction of resource transfers (d_outbound) and the drug-discovery business model (m_drug) have individually significant main effects, with *m_drug* being negatively moderated by exploitation stage (drugexploit) and further R&D activities (drugrnd). Overall, these results continue to directly support Hypothesis 5 (drug discovery) and 6 (outbound direction). The evidence regarding Hypothesis 4 (exploitation stage) is mixed, since its main effect remains insignificant, but it has a positive overall effect as part of the four-way interaction term (even after accounting for the negative effect of *drugexploit*).

- In contrast, using heteroskedasticity-consistent estimators does not impair the significance of the hypothesized effects in the ‘Contractual Provisions’ model. Limited contract duration (timelimit) and contractual flexibilities (optionality) continue to negatively impact collaborative value. Both may thus serve as mechanisms to reduce agency costs, which supports Hypotheses 8 and 9. Their effects may be subadditive, although their positive interaction effect again fails to gain significance. Also in line with Hypothesis 8, the actual length of a fixed-term alliance (time) has a significantly positive valuation effect. That is, even if limited duration reflects agency costs, long-term collaboration may facilitate inter-partner learning and the evolution of trust. The observed effects also are consistent for the more comprehensive ‘Combined Effects’ model.
- The main rationale underlying Hypothesis 11 is supported when controlling for heteroskedasticity. In particular, the detrimental effect of market volatility in ‘outbound’ transactions (mktvolbtout) remains significant, when using White’s standard errors. In all, Hypothesis 11 thus remains incorrectly specified, since market dynamics reduce the benefits of collaborative agreements, when those consume previously existing flexibilities (rather than increase the value of alliances creating additional strategic options).

Table 24: Estimation Results Using Heteroskedasticity-Consistent Estimators

	Alliance Characteristics			Contractual Provisions			Market Dynamics			Combined Effects		
Variable	**Coef.**	**Sig a**	**Wh b**	**Coef.**	**Sig a**	**Wh b**	**Coef.**	**Sig a**	**Wh b**	**Coef.**	**Sig a**	**Wh b**
focalstafflog	-0.0185	***		-0.0122	**	**	-0.0152	***	***	-0.0140	***	**
ptype_ph	0.0298	*		0.0009			-0.0004			0.0008		
pregion_main	0.0384	*		0.0290		**	0.0320	*	**	0.0295		**
d_outbound	-0.0032						0.1296	***	***	0.1108	**	**
m_drug	0.0682		**							0.0603		*
f_rnd	0.0047									0.0101		
exploitation	-0.0074									-0.0029		
drugexploit	-0.0356									-0.0523		**
drugout	0.0451									0.0250		
drugrnd	-0.0811		**							-0.0652		*
rndexploit	0.0138									0.0163		
rndout	0.0022									-0.0015		
exploitout	-0.0101									-0.0174		
exploit4way	0.2059	***								0.1047	*	*
equityshort				0.0415						0.0318		
payin				0.0080			0.0071			0.0009		
value				-0.0004			0.0002			0.0000		
valuepayin				0.0017	**	**	0.0011		*	0.0011		*
timelimit				-0.0895	***	**				-0.0862	***	*
time				0.0024	***	*				0.0024	***	*
optionality				-0.0268	*	*				-0.0349	**	**
timelimitoption				0.0234						0.0375		
mktretbt							-0.0755	**		-0.0893	***	**
mktvolbt							-0.2182			-1.6124		
mktretvolbt							3.3462	*		4.1994	**	**
mktretbtout							0.0115					
mktvolbtout							-7.5279	**	**	-6.0385	**	**
intercept	0.0818		*	0.0590	*	*	0.0672			0.0824		
df	302			305			304			290		
R^2	0.1270			0.3321			0.3063			0.3556		
F	4.2829			15.2852			12.6255			7.7066		
AIC	-489.9			-577.6			-564.6			-575.0		

***/**/* indicates significance at 1%/5%/10% levels (standard)
a/b significance level for standard/White's heteroskedasticity-consistent estimators[528]

[528] Since inconstant error variance only biases the significance test for individual value drivers, heteroskedasticity-consistent regression yields the same coefficient estimates and goodness-of-fit measures as standard OLS. However, the significance levels for each coefficient estimates are adjusted for the individual variable's level of heteroskedasticity. Consequently, includes the coefficient estimates only once and reports both standard as well as White's heteroskedasticity-consistent significance levels.

Furthermore, the significance of some control variables is subject to heteroskedasticity: First, all three firm and market-level control variables loose their significance in the 'alliance characteristics' model, when using heteroskedasticity-consistent estimation. Conversely, focal firm size (focalstafflog) and collaboration with North American or European partners (pregion_main) have the expected significant effects in the three other models, supporting the predictions of Controls 3 and 5. However, collaboration with pharmaceutical firms (Control 2) remains insignificant across all four models. Second, the nominal value of payments to the focal firm arising from an alliance (valuepayin) significantly increases collaborative value in all three models, in which it appears. Control 12 thus is more consistently supported after accounting for heteroskedasticity. Third, the environmental munificence effect (i.e., stock-market returns and their interaction with volatility) become insignificant when accounting for heteroskedasticity, at least in the more parsimonious 'market dynamics' model. Yet, they maintain their significance levels in the 'Combined Effects' model, supporting Control 4.

In summary, controlling for heteroskedasticity does not substantially alter the evidence from standard OLS analyses. Some variation exists in the more limited sub-models, but all discussed effects maintain their significance (some at reduced levels) in the 'Combined Effects' model.[529] Consequently, the arguments regarding hypothesized effects brought forward in section 5.3.2 stand after accounting for heteroskedasticity.

5.3.3.3 Estimation after Omitting Outliers

To ensure that the documented effects can be regarded as representative for the overall sample, all main analyses were repeated for a subsample excluding outlying observations (i.e., Cook's Distance greater than 1

[529] The reasons for such variation are purely statistical in nature. Specifically, accounting for a greater number of influences may reduce the inconsistencies in the error variances for some variables. Indeed, a comparison of Szroeter test statistics across the different models reveals a reduced level of heteroskedasticity in the 'Combined Effects' for many variables (see Table 162 in the appendix for details). Most notably, this includes all transaction context dimensions and their four-way interaction (exploit4way) as well as the stock return index (mktretvol). Both of these are significant in the more comprehensive model, but insignificant in the submodels. Consequently, some of the observed heteroskedasticity in the concise submodels may be due to an omitted variable bias.

and/or standardized residuals over 3 in absolute terms). Table 25 presents a summary of the findings.[530]

Overall, excluding outlying observations does not substantially affect the direction, magnitude, or significance of many hypothesized and control effects. For instance, focal firm size (focalstafflog) exhibits a significantly negative value impact across all model specifications. Similarly, market volatility consistently reduces collaborative value in outbound transactions (mktvolbtout). However, the evidence summarized in **Table 25** shows two substantial patterns and deviations when excluding outliers:

- As omitting outlying observations reduces overall variation in the dependent variable, some effects no longer are penalized for heteroskedasticity. Specifically, the four-way interaction of alliance characteristics (exploit4way), the interaction indicating that focal firm concurrently receive milestone and royalty payments (mileroyallong), as well as the control for pharmaceutical partner firms (ptype_ph) are consistently significant in the reduced-sample models. Some of the heteroskedasticity present in the full-sample models thus may be due to observations at the extremes of sample distribution.[531]
- The value impact of contractual provisions is substantially reduced, when omitting outliers. In particular, limited duration (timelimit), length of duration (time), and contractual flexibilities (optionality) no longer significantly influence value creation. Consequently, these effects may mostly explain observations at the outskirts of the distribution, rather than being consistently relevant across the entire sample. For instance, the information asymmetries and agency problems associated with the choice of time-limited or particularly flexible alliance

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530 Recall that omitting outliers is not a required correction, since the 'outliers' corrected for are valid observations. However, this may provide more detailed insights into the mechanics of the observed effects, since some of the excluded observations experienced extremely high ARs. To conserve space, the detailed estimation results are presented in Table 166 of the appendix.

531 In further support, formal heteroskedasticity effects show lower test scores for the reduced sample. However, they remain significant for all submodels. Only in the 'Combined Effects' model (Table 162 in the appendix) the aggregate Breusch-Pagan test for heteroskedasticity comes out insignificant. Consequently, the combination of concurrently controlling for all hypothesized effects (i.e., mitigating potential omitted variable biases) and dropping 'outlying' observations may account for the two key sources of inconstant error variance.

Additionally, the reduced variation in observed AR leads to the model quality indicators (adjusted R^2 and F-Score) being substantially lower when correcting for outliers.

contracts may preclude potentially high-value collaboration from receiving full appreciation by investors.

Table 25: Overview of Significant Effects in Regressions With/Excluding Outliers

Hypothesis/ Control	Not Correcting for Outliers		Excluding Outliers	
	Standard OLS Estimators	White Estimators	Standard OLS Estimators	White Estimators
Hypothesis 4	-	-	-	-
Hypothesis 5	-	m_drug (+) drugrnd (–)	m_drug (+) drugrnd (–)	m_drug (+) drugrnd (–)
Hypothesis 6	-	-	-	-
Hypotheses 4-6	exploit4way (+)	-	exploit4way (+)	exploit4way (+)
Hypothesis 7	mileroyallong	-	mileroyallong	mileroyallong
Hypothesis 8	timelimit (–) time (+)	timelimit (–) time (+)	-	-
Hypothesis 9	optionality (–)	optionality (–)	-	-
Hypothesis 10	-	-	-	-
Hypothesis 11	mktvolbtout (–) mktretvolbt (+)	mktvolbtout (–) -	mktvolbtout (–) -	mktvolbtout (–) -
Control 2	*	-	ptype_ph (+)	ptype_ph (+)
Control 5	focalstafflog (+)	focalstafflog (+)	focalstafflog (+)	focalstafflog (+)
Control 11	equityshort (+)*	-	-	-
Control 12	valuepayin (+)*	valuepayin (+)	valuepayin (+)*	valuepayin (+)
Control 3	mktretbt (–)	-	-	-
Control 4	pregion_main (+)*	pregion_main (+)*	pregion_main (+)*	pregion_main (+)*

* Significance varies with model specification
[Variable shown if significant in majority of cases]

In summary, most determinants of collaborative value are unaffected or even reinforced by the exclusion of some outlying and influential observations. Contrarily, contractual provisions only significantly affect AR for the entire sample.

5.4 Firm-Specific Effects and Self-Selection

In addition to controlling for standard regression assumptions and potential distortions due to outliers, the present study accounts for violations of the independence assumption due to (a) DBFs forming multiple alliances of the study period and (b) similar factors potentially driving the rate of alliance formation and the value of individual alliances. Section 5.4.1 focuses on firm-specific effects using different panel-data models, while subsection 5.4.2.2 presents models correcting for (self-)selection in sample composition.

5.4.1 Panel Model Estimation Results

5.4.1.1 Biotechnology-Specific Alliance Characteristics

Correcting for firm-specific variation in abnormal announcement returns generally does not alter the findings from the preceding analyses. Table 26 presents the relevant estimation results relative to the corresponding models applying standard OLS.

Table 26: Panel-Data Estimation Results (Alliance Characteristics)

	Main Effects Only						Including Interactions					
Variable	**OLS**		**Fixed Effects**		**Random Effects**		**OLS**		**Fixed Effects**		**Rand. Effects**	
Focalstafflog	-0.0174	***	-0.0147		-0.0147		-0.0185	***	-0.0144		-0.0173	**
Ptype_ph	0.0262	*	0.0396	**	0.0339	**	0.0298	*	0.0399	**	0.0326	**
Pregion_main	0.0447	**	0.0384		0.0393	*	0.0384	*	0.0284		0.0330	
d_outbound	0.0243	*	0.0312	**	0.0304	**	-0.0032		0.0425		0.0123	
m_drug	0.0277	**	0.0196		0.0215		0.0682		0.0872		0.0727	
f_rnd	0.0226		0.0301		0.0283		0.0047		0.0525		0.0199	
Exploitation	0.0179		0.0190		0.0172		-0.0074		0.0640	*	0.0094	
Drugexploit							-0.0356		-0.0755		-0.0451	
Drugout							0.0451		0.0539	*	0.0453	
Drugrnd							-0.0811		-0.1022	*	-0.0872	*
Rndexploit							0.0138		-0.0422		-0.0016	
Rndout							0.0022		-0.0316		-0.0094	
Exploitout							-0.0101		-0.0777	*	-0.0286	
exploit4way							0.2059	***	0.2482	***	0.2186	***
Intercept	0.0353		0.0171		0.0199		0.0818		0.0166		0.0652	
Df	309		266		308		302		259		301	
R^2	0.0717		-0.0916		0.0889 [a]		0.1270		-0.0337		0.1637[a]	
F	4.4846		3.3564		25.73 [a]		4.2829		3.3353		52.09[a]	
AIC	-477.1		-562.3		-		-489.9		-574.0		-	
FE/RE Tests	-		***		n.s.		-		***		n.s.	
Hausman Test	-		n.s.				-		***			

***/**/* indicates significance at 1%/5%/10% levels

a Model fit indicators for RE models: overall R^2 and chi^2 (vs. adjusted R^2 and F)

In the (left) model including only the main effects of the four transaction dimensions, outbound direction of resource transfers (d_outbound) remains a significant driver of collaborative value. Although the drug-discovery business model dummy (m_drug) looses its significance, it retains a substantially positive coefficient, similar to the ones for exploitation stage (exploitation) and further R&D activities (f_rnd). Its loss in significance may reflect that the value of drug-discovery alliances does not equally apply to all focal firms.[532]

In the more elaborate model including interaction effects (right), the four-way interaction term *exploit4way* is significant across both fixed and random-effects specifications. While only Hypothesis 6 thus receives direct support, the four transaction dimensions continue to join forces in extremely high-value alliances. Additionally, exploitation and several two-way interaction terms become significant (particularly in the fixed-effects model). In brief, these imply that inbound exploitation-stage transactions and outbound, non-R&D, non-exploitation drug-discovery alliances may create substantial value. Given that these effects are independent from the four-way interaction term, this suggests that biotechnology firms may create collaborative value through a variety of alliances, although the expected value impact is much more modest than for the constellation characterized by *exploit4way*.

The various specification tests are summarized at the bottom of Table 26. For both main-effects and interactions models, firm fixed-effects are collectively significant (F-Test) at the 1% level. This indicates substantial differences in the average ARs experienced by focal firms. While the Breusch-Pagan LM-Test for random effects fails to turn out significant, the Hausman specification test only demonstrates a bias arising from using random instead of fixed effects for the more extensive model. In that case, only the fixed-effects model provides an unbiased account of the impact firm-specific influences have on estimation results. Unfortunately, this comes at the loss of 43 degrees of freedom and compromised goodness-of-fit measures (in particular, a negative adjusted R^2 value).

Finally, accounting for firm-level variation in ARs affects some control variables. Specifically, the significance of firm size is erased by firm fixed effects and substantially reduced by random effects. This show that changes in the size of the individual firm either do not affect ARs or only

532 More specifically, not all focal firms have proprietary drug-discovery operations, which could form the basis of such collaboration. Consequently, the loss in significance when correcting for firm-specific effects suggests that drug-discovery firms in general receive higher announcement ARs than other DBFs.

have a limited impact. A similar pattern applies to collaboration with partners from Europe and/or North America (pregion_main), leaving only collaboration with pharmaceutical partners (ptype_ph) unaffected (i.e. applying to all focal firms).

5.4.1.2 Compensation Structure and Contractual Provisions

As the evidence in Table 27 shows, controlling for firm-specific variation in ARs (via either fixed or random-effects methods) does not substantially affect the valuation impact of compensation structures and contractual provisions.

With regard to the financial flows between transacting parties (left panel), receivable milestone and royalty payments are consistently value-increasing. In support of Hypothesis 7, focal-firm value thus increases, when their relatively large share of future revenue streams may mitigate agency costs. Among contractual provisions (right panel), the effects of time-limited collaboration and contract duration are robust to firm-specific influences, supporting Hypothesis 8. However, contractual flexibilities become insignificant, when accounting for firm-specific variation. While this is not surprising given the limited significance they held in the first place, it opposes the findings from OLS and heteroskedasticity-consistent estimation with regard to Hypothesis 9.[533]

All firm-level control variables, which already were of little influence in the OLS setting, are consistently rendered insignificant by fixed or random effects. Among the compensation-related controls incoming equity investments (compensation structure model) and the nominal value of incoming payments (contractual provisions model) maintain their effects, although the latter becomes insignificant when using the fixed effects approach.

Both hypothesized models lead to the sample conclusions regarding the choice of panel-data models. The F-Test for firm-specific effects is highly positive, whereas the Breusch-Pagan LM-Test for random effects is insignificant. However, the Hausman test shows no bias, i.e., favoring the random effects specification.

[533] As further analyses show, optionality maintains its significance in the fully fletched model or when controlling for heteroskedasticity in addition to firm-specific variation. For the corresponding evidence, see ‘entire sample’ panel in Table 29 as well as Table 163 in the appendix.

Table 27: Panel-Data Estimation Results (Compensation & Contractual Provisions)

	Compensation Structure			Contractual Provisions		
Variable	**OLS**	**Fixed Effects**	**Rand. Effects**	**OLS**	**Fixed Effects**	**Rand. Effects**
focalstafflog	-0.0125 **	-0.0108	-0.0090	-0.0122 **	-0.0141	-0.0110
ptype_ph	0.0089	0.0206	0.0163	0.0009	0.0119	0.0075
pregion_main	0.0294	0.0238	0.0244	0.0290	0.0264	0.0264
equityshort	0.1262 ***	0.1134 ***	0.1172 ***	0.0415	0.0267	0.0294
payin	0.0672	0.0905	0.0748	0.008	0.0110	0.0104
value				-0.0004	0.0000	-0.0002
valuepayin				0.0017 **	0.0012	0.0015 **
guarantlong	-0.0009	0.0034	0.0045			
guarantshort	-0.0382	-0.0354	-0.0329			
milestonelong	-0.0987	-0.1055	-0.0929			
milestoneshort	-0.0641	-0.1148	-0.1146			
royaltylong	-0.0793	-0.1082	-0.0938			
royaltyshort	0.0088	0.0199	0.0199			
guarmilelong	0.0252	0.0182	0.0168			
guarmileshort	0.0606	0.0874	0.0880			
guarroyallong	0.0229	0.0307	0.0294			
guarroyalshort	-0.0004	-0.0260	-0.0281			
mileroyallong	0.1226 **	0.1521 **	0.1388 **			
mileroyalshort	0.0469	0.0788	0.0797			
timelimit				-0.0895 ***	-0.1029 ***	-0.1003 ***
time				0.0024 ***	0.0028 ***	0.0027 ***
optionality				-0.0268 *	-0.0212	-0.0230
timelimitoption				0.0234	0.0288	0.0281
intercept	0.0546	0.0433	0.0346	0.0590 *	0.0675	0.0522
df	299	256		305	262	
R^2	0.1136	-0.0269	0.1563 [a]	0.3321	0.2116	0.3531 [a]
F	3.3814	3.0424	55.83 [a]	15.2852	12.6199	158.76 [a]
AIC	-482.2	-573.8		-577.6	-662.2	
FE/RE Tests	-	***	n.s.	-	***	n.s.
Hausman Test	-	n.s.		-	n.s.	

***/**/* indicates significance at 1%/5%/10% levels

a Model fit indicators for RE models: overall R^2 and chi^2 (vs. adjusted R^2 and F)

5.4.1.3 Environmental Dynamics and Firm Development

The influence of environmental dynamics on collaborative value may also differ across firms, i.e. be the source of firm-level heterogeneity in the observed ARs. Table 28 exhibits two sets of models addressing such issues.

Table 28: Panel-Data Estimation Results (Environmental Dynamics)

Panel	Main Effects and Interactions			Interactions with Outbound Direction		
Variable	**OLS**	**Fixed Effects**	**Rand. Effects**	**OLS**	**Fixed Effects**	**Rand. Effects**
focalstafflog	-0.0148 ***	-0.0118	-0.0145 *	-0.0152 ***	-0.0144	-0.0156 **
ptype_ph	0.0026	0.0094	0.0023	-0.0004	0.0100	0.0027
pregion_main	0.0301	0.0262	0.0275	0.0320 *	0.0245	0.0263
payin	0.0108	0.0075	0.0066	0.0071	0.0068	0.0055
value	0.0001	0.0006	0.0004	0.0002	0.0005	0.0004
valuepayin	0.0013 *	0.0008	0.0010	0.0011	0.0008	0.0010
d_outbound		0.0165	0.0182	0.1296 ***	0.0875 *	0.1186 **
mktretbt	-0.0547 *	-0.0465	-0.0564 *	-0.0755 **	-0.0614 *	-0.0782 **
mktvolbt	-3.8035 *	-5.0371 **	-4.5201 **	-0.2182	-2.7588	-1.2646
mktretvolbt	2.5242	2.1819	2.5128	3.3462 *	2.6869	3.2043 *
mktretbtout				0.0115	0.0108	0.0177
mktvolbtout				-7.5279 **	-4.6513	-6.6308 **
intercept	0.1268 ***	0.0571	0.0615	0.0672	0.1056	0.0905
Df	307	265		304	261	
R^2	0.2965	0.1578	0.3100 [a]	0.3063	0.171	0.3310 [a]
F	15.7984	13.7732	131.84 [a]	12.6255	10.014	145.44 [a]
AIC	-563.10	-643.67		-564.64	-645.51	
FE/RE Tests [b]	-	***	n.s.	-	***	n.s.
Hausman Test	-	n.s.		-	n.s.	

*
//* indicates significance at 1%/5%/10% levels
a Model fit indicators for RE models: overall R^2 and chi^2 (vs. adjusted R^2 and F)
b Significance of F-Test for firm fixed and Breusch-Pagan test for random effects

The more basic setup (left panel), shows environmental uncertainty (mktvolbt) maintaining its significantly negative coefficient in both fixed and random effects models. This is consistent with all earlier analyses. Contrarily, the interaction effect testing for the option-based logic underlying Hypothesis 11 (mktvolbtout, right panel) is rendered insignificant by fixed firm-effects (in spite of a significantly negative coefficient). This suggests that the value-reducing effect associated with exercising proprietary flexibilities under conditions of high environmental uncertainty may be limited to a subset of firms. This is consistent with the above evidence showing this effect to be more pronounced for smaller, less-developed firms [see subsection 5.3.2.2 on page 270]. While the stock-market return measure (mktretbt) becomes insignificant in the fixed-effects model, it also remains substantially negative throughout, concurring with Control 4. This effect is consistently significant across both basic and extensive analyses.

The remaining evidence in Table 28 is similar to the other panel-data models. In particular, the (in)significance of control variables is largely unaffected, with the exception of firm size (focalstafflog) loosing its influence in the fixed-effects models and the nominal value of payments receivable (value) being insignificant. The specification test result exhibit the known pattern of significant inter-firm variation in ARs (F-Test), but no bias from using a random-effects model (Hausman), although random effects were not indicated in the direct test (Breusch-Pagan).

Finally, the combined-effects model was reviewed on a split-sample basis to revisit the differential effects of value drivers on further and less-developed firms (Hypothesis 12). Table 29 presents the evidence for fixed and random-effects models as well as both robust and standard OLS estimates.[534]

In line with the preceding analyses, most significant effects are remarkably consistent across different methodological specifications. Consequently, the characteristic differences in the value-creation mechanisms of larger and smaller DBFs discussed in subsection 5.3.2.2 are by-and-large unaffected by the choice of modeling approaches.

Without reiterating the findings discussed with regard to Table 22 (p. 284), three main conclusions are supported by the panel-data models: First, the effects of biotechnology-specific alliance characteristics on the entire-sample level (left panel) mostly reflect the combined effects of both subsamples, whereas the value-creation profiles of larger and smaller firms differ substantially. Second, the agency costs associated with time-limited collaboration primarily are born by less developed firms, who may be subject to greater information asymmetries. Conversely, the negative value impact of contractual flexibilities homogeneously applies to further and less-developed firms. Third, while environmental munificence mostly affects larger firms, environmental uncertainty may more strongly reduce the value of outbound collaborative ventures for smaller firms.

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[534] To conserve space, the influence of heteroskedasticity on subsample results was not addressed previously. As evidenced in Table 29, all effects significant applying standard OLS remain so when using White's heteroskedasticity-consistent standard errors. In addition, some important effects gain significance, most notably including *exploit4way* (large-firm subsample) and *mktvolbtout* (small-firm subsample).

Table 29: Panel-Data Estimation Results (Firm Development)

Panel	Entire Sample					Large-Firm Subsample					Small-Firm Subsample				
Variable	**OLS**	**a**	**b**	**Fixed Effects**	**Random Effects**	**OLS**	**a**	**b**	**Fixed Effects**	**Random Effects**	**OLS**	**a**	**b**	**Fixed Effects**	**Random Effects**
focalstafflog	-0.0140	***	**	-0.0126	-0.0136 **	-0.0075			-0.0159	-0.0075	-0.0251			-0.0241	-0.0228
ptype_ph	0.0008			0.0123	0.0040	0.0135			0.0160	0.0135	-0.0083			0.0176	-0.0077
pregion_main	0.0295		**	0.0237	0.0246	0.0238			0.0168	0.0238	0.0353		*	0.0367	0.0360
m_drug	0.0603		*	0.0687	0.0624	0.0841	*	**	0.1117 *	0.0841 *	-0.0319			-0.0916	-0.0397
f_rnd	0.0101			0.0498	0.0271	0.0255			0.0163	0.0255	0.0153			0.0618	0.0193
exploitation	-0.0029			0.0539	0.0152	0.0326			0.0389	0.0326	-0.1135	*	*	-0.0250	-0.1111 *
d_outbound	0.1108	**	**	0.0935	0.1098 **	0.0849			0.0883	0.0849	0.1129		*	0.0208	0.1090
drugexploit	-0.0523		**	-0.0875 *	-0.0655	-0.0850	*	***	-0.1119 **	-0.0850 *	-0.0073			-0.0738	-0.0093
Drugout	0.0250			0.0383	0.0291	0.0028			0.0149	0.0028	0.1019	**	**	0.1376 **	0.1039 **
Drugrnd	-0.0652		*	-0.0809 *	-0.0715	-0.0715		***	-0.0878 *	-0.0715	-0.0087			0.0343	-0.0030
Rndexploit	0.0163			-0.0299	0.0010	0.0102			0.0060	0.0102	0.0711			0.0450	0.0719
Rndout	-0.0015			-0.0348	-0.0177	-0.0028			-0.0021	-0.0028	-0.0346			-0.0492	-0.0364
Exploitout	-0.0174			-0.0665 *	-0.0366	-0.0408		*	-0.0702 *	-0.0408	0.1172			0.0681	0.1186
exploit4way	0.1047	*	*	0.1494 **	0.1233 **	0.0599		*	0.1179	0.0599	0.0107			0.0765	0.0068
equityshort	0.0318			0.0170	0.0245	0.0237			-0.0049	0.0237	0.001			-0.0362	-0.0038
Payin	0.0009			0.0002	0.0006	0.0051			-0.0101	0.0051	0.0097			0.0183	0.0104
value	0.0000			0.0002	0.0001	-0.0003			-0.0002	-0.0003	0.0183	***	***	0.0228 ***	0.0187 ***
valuepayin	0.0011		*	0.0008	0.0011	0.0005			0.0005	0.0005	-0.0171	***	***	-0.0216 ***	-0.0175 ***
timelimit	-0.0862	***	*	-0.0928 ***	-0.0900 ***	-0.0202			-0.0062	-0.0202	-0.1318	***	**	-0.1378 ***	-0.1339 ***
time	0.0024	***	*	0.0025 ***	0.0025 ***	0.0003			0.0001	0.0003	0.0041	***	**	0.0040 ***	0.0041 ***
optionality	-0.0349	**	**	-0.0309 *	-0.0340 **	-0.0228			-0.0325	-0.0228	-0.0388		*	-0.0237	-0.0366
timelimitoption	0.0375			0.0503	0.0463	-0.0150			0.0164	-0.0150	0.0345			0.0561	0.0370
mktretbt	-0.0893	***	**	-0.0690 **	-0.0874 ***	-0.0897	**	**	-0.0754 *	-0.0897 **	-0.0474			0.0066	-0.0443
mktvolbt	-1.6124			-4.3711 *	-2.6135	-3.0590			-3.8420	-3.0590	0.4990			-4.2916	0.3522
mktretvolbt	4.1994	**	**	3.2465 *	4.0475 **	4.4989	**	*	3.6192	4.4989 **	2.4018			-0.0880	2.2208
mktvolbtout	-6.0385	**	**	-3.0389	-5.0315 *	-3.8985			-3.3470	-3.8985	-6.9949		*	-1.3440	-6.7525

***/**/* indicates significance at 1%/5%/10% levels
a/b Significance for standard OLS regression/ White Estimators

Table 29: Panel-Data Estimation Results (Firm Development)/(continued)

Panel	Entire Sample					Large-Firm Subsample					Small-Firm Subsample				
Variable	OLS	a	b	Fixed Effects	Random Effects	OLS	a	b	Fixed Effects	Random Effects	OLS	a	b	Fixed Effects	Random Effects
Intercept	0.0824			0.0854	0.0871	0.0494			0.1242	0.0494	0.1126			0.1357	0.1018
Df	290			247	289	131			109	130	132			101	131
R^2	0.3556			0.2358	0.4059 [c]	-0.0473			-0.2185	0.1261 [c]	0.5049			0.3904	0.5860 [c]
F	7.7066			6.4043	192.94 [c]	0.7271			0.7634	18.90 [c]	7.1967			6.0838	185.37 [c]
AIC	-574.96			-660.80		-351.21			-383.69		-248.62			-311.77	
Heterosked./ FE/RE Tests [d]	-	***		***	n.s.	-	n.s.		n.s.	n.s.	-	***		*	n.s.
Hausman Test	-				*	-				n.s.	-				n.s.

***/**/* indicates significance at 1%/5%/10% levels

a/b Significance for standard OLS regression/ White Estimators

c For random-effects models, model fit indicators are overall R2 and chi2 (rather than adjusted R2 and F)

d Significance refers to Breusch-Pagan test for heteroskedasticity, F-Test for firm fixed-effects, and Breusch-Pagan test for random effects, respectively

Note that the degrees of freedom for the fixed effects models differ across subsamples. Specifically, this reflects the smaller number of different firms contained in the larger-firm subsample, since larger firms tend to have a greater number of alliances (per firm).

With regard to overall model fit, different specifications consistently show great explanatory power for the small-firm subsample. In contrast, all models fail to account for a substantial share of the variation in large-firm ARs. Similarly, it comes as no surprise that specification tests do not substantiate firm-specific effects in the larger-firm subsample. The specification test results on the small-firm subsample indicating firm-specific effects (F-Test), similar to the overall subsample, but do not further evidence of inconsistency, when using random-effects models.[535]

5.4.2 Impact of Sample (Self-)Selection

5.4.2.1 Estimation of Sample Selection Function

As outlined in subsection 4.5.2.2, the implicit sample selection mechanism was modeled for all days in which focal firms were 'at risk' of forming an alliance.[536] Table 30 shows the estimation results of different models.

Contrary to the previous analyses, the figures in Table 30 are (partial) hazard ratios. These represent the relative change in the likelihood (hazard) of alliance formation induced by a one unit change in the independent variable (holding all other variables constant). For instance, a hazard ratio of 0.9986 on the focal-firm age variable (agep in the 'Main' effects model) indicates that an additional day of age decreases the hazard of an additional alliance per unit of time by 1.4 percentage points.

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[535] Further analyses found fixed-effects models also being subject to heteroskedasticity. This suggests that both may require to be simultaneously controlled for to ensure the validity and reliability of estimation results [see (Petersen 2007) for a discussion]. Table 168 in the appendix exhibit the estimation results of panel-data models using heteroskedasticity-consistent standard errors, which are consistent with the main text.

[536] Specifically, the time at risk does not include time periods prior to focal firms IPOs (recall that 26 of the 46 firms went public after January 1997) or after firms were acquired, merged, or disbanded. Additionally, an alternative specification was used accounting only for the time periods between alliance formation announcements, i.e., omitting the intermediate non-event days. The results differed slightly with regard to year dummies but other results were generally consistent across both models.

Table 30: Selection Model Estimation Results (Cox Proportional Hazard)

Variable									
Name	**Explanation**	**Main**		**Inter**		**Count**		**Year**	
agep	Firm Age (days)	0.9986	**	0.9957	***	0.9959	***	0.9961	***
focalstaff	Firm Size (Staff)	1.7328	**	0.9768		1.1655		1.1491	
priortrans	# of prior Alliances	1.0200		1.0170		0.9997		0.9986	
focalp5	Patent Count (5year)	0.9962		0.9960		0.9940		0.9942	
focalncf	Net Cash flow	1.0000		1.0000		1.0000		1.0000	
focalq	Tobin's q	1.0496		1.0421		1.0372		1.0106	
mktactivity	Alliance Activity	1.0106	*	1.0140	***	1.0154	***	0.9995	
mktretbt	Stock-Mkt Climate	0.7804		1.5410		1.7434		0.9595	
mktvolbt	Stock-Mkt Volatility	8.78E+45	***	3.26E+50	***	3.49E+50	***	4.87E+29	
agestaff	Firm Age X Size			1.0004	***	1.0004	***	1.0004	***
priorp5	Patent Count X # of prior Alliances			1.0000		1.0001		1.0001	
mktretvolbt	Stock-Mkt Climate X Volatility			0.0000		0.0000		0.0001	
benelux	Firm from BE/NL					1.2870		1.3193	
scand	Firm from SW/NO					0.9507		1.0048	
germany	Firm from GER					1.3771		1.5341	
fritch	Firm from F/IT/CH					0.3168	**	0.3759	*
y2	1998 dummy							1.3976	
y3	1999 dummy							1.5053	
y4	2000 dummy							3.2107	
y5	2001 dummy							6.7796	*
y6	2002 dummy							3.1183	
y7	2003 dummy							1.8230	
N overall	Days 'at risk'	5.38E+04		5.38E+04		5.38E+04		5.38E+04	
N failed	Alliances Formed	347		347		347		347	
LL	Log-Likelihood	-2122.33		-2085.27		-2070.58		-2059.44	
Chi^2	Wald-Test Statistic	90.20		92.74		119.28		279.24	
Pseudo-R^2		0.0707		0.0869		0.0934		0.0982	

***/**/* indicates significance at 1%/5%/10% levels
Figures indicate hazard ratios unless noted otherwise

While the evidence on determinants of alliance formation is not directly linked to question of collaborative value creation, factors driving collaborative activity may have the strongest indirect valuation effect. Their significance may be most affected in the main regression, when the likelihood of event occurrence is controlled for. Specifically, three types of variables appear to determine the rate of alliance formation:

- Firm age reduces the likelihood of alliance formation across all model specifications, which appears contrary to the general notion that focal firms' commercial and social capital (as well as reduced information asymmetries) facilitate alliance formation (see subsections 2.2.2.1/2.2.2.2 and 2.3.2.1). Instead, the perceived need of DBFs to gain legitimacy by collaborating may decrease, once become better established. However, focal firm size has a significantly positive effect ('Main Effects' model), which primarily results from it moderating the age effect ('Interaction' model). That is, firms may augment formation rates as they mature, but only if they grow in addition to aging.[537] In the specific European biotechnology setting, increased firm size may be prerequisite for establishing additional technology and service alliances or may be indicative of advanced stage drug candidates. Focal firm resource endowments do not appear to further affect alliance formation.

- The overall level of interorganizational activity in the market is associated with a higher likelihood of alliance formation for the individual firm. This suggests that DBFs choose to ally in response to environmental pressures (or as a result of mimetic behavior). While the magnitude of this effect is rather modest, environmental uncertainty (i.e., stock-market volatility) has explosive impact on alliance formation.[538] Thus, both dimensions of environmental dynamics argued to influence collaborative value (Hypotheses 10 and 11) substantially increase the rate of alliance formation.
- Dummy variables for regional clusters of countries and individual years within the study period also affect the likelihood of collaboration. In particular, focal firms from France, Italy, and Switzerland (fritch in the 'Country' model) are significantly less likely to enter into collaborative ventures, whereas all other sample countries appear to be rather homogeneous.[539] alliance activity. In line with the pattern exhibited in Figure

537 As the functional specification of the proportional hazard function is multiplicative, the arithmetics of trading off both effects are more messy than for additive models. While an additional employee corresponds to a 73.28% increase in the likelihood of alliance formation, one day of aging only reduces the hazard by 1.4%. On average, one additional employee per year thus would still lead to an increase in the predicted likelihood of alliance formation (the equivalent would be about 393 days).

538 For instance, a one standard-deviation rise in market transactions increases the predicted alliance formation hazard by about 26.6%. In addition, this effect is limited to the full-model (i.e., explicitly modeling all non-event days). A reduced model only analyzing the time between alliance formation announcements did not further evidence of it being significant (Table 169 of the appendix). Similarly, focal firms' prior transactions and focal firm patents lead to higher likelihoods of alliance formation, but are non-additive.
Conversely, the extremely high coefficients for the market uncertainty variable are due its relatively low variation (i.e., its standard deviation is only ¼th of its mean).

539 The base category for the regional dummy variables is the UK. Consequently, French, Italian, and Swiss firms exhibit a 68.32% lower propensity of collaborating than UK firms. All other regional differences are statistically insignifi-

22, the likelihood of alliance formation is highest during the 2000-2002 period, although only the year 2001 dummy comes out significant (relative to the base year 1997). This is of particular importance, since the model specification accounts for the greater number of sample firms during later years (i.e., more days in which firms are ‘at risk’ of forming alliances). The significant coefficient for the 2001 dummy thus indicates that the rate of alliance formation is significantly higher even after controlling for the greater number of focal firms.[540]

In brief, the analysis of alliance formation rates indicated that firm development and environmental dynamics significantly most strongly affect the occurrence of collaboration. Complementary regional and time-specific influences also affect focal firms’ allying decisions.

5.4.2.2 Estimation Results Accounting for Sample Selection

As proposed by Hypothesis 13 the (self-)selection effects reflected in the preceding analysis of alliance formation may moderate the direct effects of the given variables on collaborative value. Table 31 presents the results of the second-stage regressions, correcting for the predicted hazard of an alliance forming on the day of the actual announcements.

Contrary to Hypothesis 13, (self-)selection does not appear to influence the value generated by collaborative agreements. Overall, the evidence in Table 31 does not indicate systematic differences in regression results due to controlling for (self-)selection:

- Aside from minor changes in the levels of significance for some variables, none of the environmental and firm-level variables is affected by (self-)selection. In particular, the effects of firm size and market volatility maintain their direction and magnitude.[541] Since these factors also

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cant, although the coefficients for Belgian, Dutch (+28.70%) and German (+37.71%) firms are quite substantial.

540 Controling for individual years also renders the time-varying environmental dynamics variables (market activity and environmental uncertainty) insignificant. As the main objective of this exercise, however, is to assess the indirect effects of these variables (and the additional explanatory power of the ‘Year’ model is limited), the present study calculated the hazard ratio (i.e., the relative risk of an alliance forming on a given sample day) based on the ‘Country’ model.

541 The only notable difference is that the intraction of market volatility with outbound direction of resource transfers (mktvolbtout) looses its significance in the random effects specification. However, the coefficient even increases in magnitude (-5.0766, p=0.1018) and the main effect of market volatility remains significantly negative, when dropping the interaction term. Moreover,

significantly affected the likelihood of alliance formation, they have independent direct and indirect effects on collaborative value creation.

- Notable changes only occur with regard specific transaction characteristics. Specifically, the significance of the four-way interaction, the drugrnd and drugexploit interactions as well as the drug-discovery business model are reduced. This may reflect that particular observations exhibiting these characteristics were highly (un)likely to occur, which reduces their relative weight in the estimation outcomes. As the magnitude of these variables does not change substantially and no clear patter of deviation is observable, these effects may be of minor importance.

The selection variable lambda does not gain significance in any model specification. This suggests that the (predicted) likelihood of alliance formation does not influence the value created by a given alliance. Anticipatory effects may not be substantial or may draw on a broader base of underlying factors not related to the value impact of alliances.[542]

mktvolbtout remains significant in the OLS model (with White standard errors) and in all RE models using other selectivity corrections (i.e., based on other specifications in the first-stage model). Consequently, the net effect of (self-)selection correction on the impact of environmental uncertainty is marginal.

542 As the explanatory power of the Cox models was limited (pseudo R^2 measure < 0.1), the likelihood of alliance formation may be too difficult to accurately predict on a daily basis (as needed for correcting an event study) or for an industry setting, where collaboration is common (i.e., variation in alliance formation rates may be smaller than for other contexts).

Table 31: Estimation Results Correcting for (Self-)Selection in Alliance Formation (Based on Cox Proportional Hazard Model)

Variable	Without Selectivity Correction			With Selectivity Correction		
	OLS/ White	Fixed Effects	Rand. Effects	OLS/ White	Fixed Effects	Rand. Effects
focalstafflog	-0.0140 **	-0.0126	-0.0136 **	-0.0148 **	-0.0112	-0.0145 **
ptype_ph	0.0008	0.0123	0.0040	-0.0069	0.0043	-0.0039
pregion_main	0.0295 **	0.0237	0.0246	0.0268 *	0.0196	0.0205
m_drug	0.0603 *	0.0687	0.0624	0.0525	0.0441	0.0448
f_rnd	0.0101	0.0498	0.0271	0.0128	0.0487	0.0286
exploitation	-0.0029	0.0539	0.0152	-0.0066	0.0533	0.0125
d_outbound	0.1108 **	0.0935	0.1098 **	0.1160 **	0.0945	0.1140 *
drugexploit	-0.0523 **	-0.0875 *	-0.0655	-0.0531 *	-0.0736	-0.0590
drugout	0.0250	0.0383	0.0291	0.0353	0.0512 *	0.0414
drugrnd	-0.0652 *	-0.0809 *	-0.0715	-0.0650	-0.0622	-0.0609
rndexploit	0.0163	-0.0299	0.0010	0.0138	-0.0317	-0.0019
rndout	-0.0015	-0.0348	-0.0177	-0.0016	-0.0334	-0.0181
exploitout	-0.0174	-0.0665 *	-0.0366	-0.0181	-0.0681 *	-0.0377
exploit4way	0.1047 *	0.1494 **	0.1233 **	0.1072	0.1361 *	0.1182 *
equityshort	0.0318	0.0170	0.0245	0.0248	0.0067	0.0174
payin	0.0009	0.0002	0.0006	0.0020	0.0003	0.0020
value	0.0000	0.0002	0.0001	0.0001	0.0005	0.0002
valuepayin	0.0011 *	0.0008	0.0011	0.0010	0.0006	0.0009
timelimit	-0.0862 *	-0.0928 ***	-0.0900 ***	-0.0931 *	-0.1088 ***	-0.1014 ***
time	0.0024 *	0.0025 ***	0.0025 ***	0.0028 *	0.0031 ***	0.0030 ***
optionality	-0.0349 **	-0.0309 *	-0.0340 **	-0.0391 **	-0.0364 **	-0.0390 **
timelimitoption	0.0375	0.0503	0.0463	0.0417	0.0611	0.0544
mktretbt	-0.0893 **	-0.0690 **	-0.0874 ***	-0.1061 **	-0.0909 **	-0.1059 ***
mktvolbt	-1.6124	-4.3711 *	-2.6135	-2.7001	-7.0624 **	-4.4055
mktretvolbt	4.1994 **	3.2465 *	4.0475 **	5.1756 **	4.6755 **	5.2042 ***
mktvolbtout	-6.0385 **	-3.0389	-5.0315 *	-6.1591 **	-3.0045	-5.0766
lambda				-0.0014	0.0006	-0.0007
intercept	0.0824	0.0854	0.0871	0.1054	0.1159	0.1199 *
Df[b]	290	247		265	224	
R^2	0.3556	0.2358	0.4059[a]	0.3642	0.2475	0.4188[a]
F	7.7066	6.4043	192.94[a]	2.5833	6.076	188.00[a]
AIC	-575.0	-660.8		-514.7	-599.6	
FE/RE Tests	-	***	n.s.		***	n.s.
Hausman Test	-	*			n.s.	

***/**/* indicates significance at 1%/5%/10% levels

a for random-effects models, model fit indicators are overall R^2 and chi^2 (rather than adjusted R^2 and F)

b The degrees of freedom for the selection-corrected models are lower than for the standard analyses. In addition to the variables included in Table 31, focal firms number of patents, prior alliances, net cashflows, and q were included in the Cox model predicting the likelihood of alliance formation. Missing data for any of these variables resulted in the (case-wise) exclusion.

Controlling for (self-)selection in alliance formation slightly increases the explanatory power of the estimated models (adjusted R^2 measure). However, this comes at the cost of reduced degrees of freedom (see note b on the following page), which reduces overall model fit (F statistic). In summary, controlling for (self-)selection thus does not improve model fit or compromise the general conclusions of this study.

6 Discussion of Results and Conclusion

"Fit no stereotypes. Don't chase the latest management fads. The situation dictates which approach best accomplishes the team's mission."

Collin Powell

6.1 Summary and Retrospective

The research objectives of the present thesis were threefold (see section 1.2.1): (1) To account for the diversity in the use of and research on corporate collaboration, (2) to extend existing research to the specific setting of European biotechnology firms, and (3) to incorporate dynamic aspects of collaborative value creation, which have so far been neglected. Together, these three factors were expected to explain a large proportion of the valuation effects observed.

Providing the base for the ensuing empirical study, a broad review of general alliance literature (chapter 2) identified five main schools of thought, most of which are assembled of several of sub-theories. For instance, the market-based perspective (section 2.2) includes both industrial organization approaches regarding collaboration as a means of reducing competitive rivalry (or internalizing technological spillovers) as well as corporate strategy arguments viewing alliances as strategic tools to gain strategic advantage vis-à-vis existing or potential competitors. This review produced an extensive set of propositions, which reflect the breadth of alliance-related thought.

Event study evidence on alliances and JVs was separately reviewed (chapter 3). Being the first of its kind, such an undertaking may have some merit in itself. Its main contribution within the overall scope of this thesis, however, was to assess the current state of value-related research. Initially, it identified several core influences on collaborative value, which need to be accounted for in subsequent research efforts. For the present study, appropriate controls were defined. At the same time, a comparison of prior

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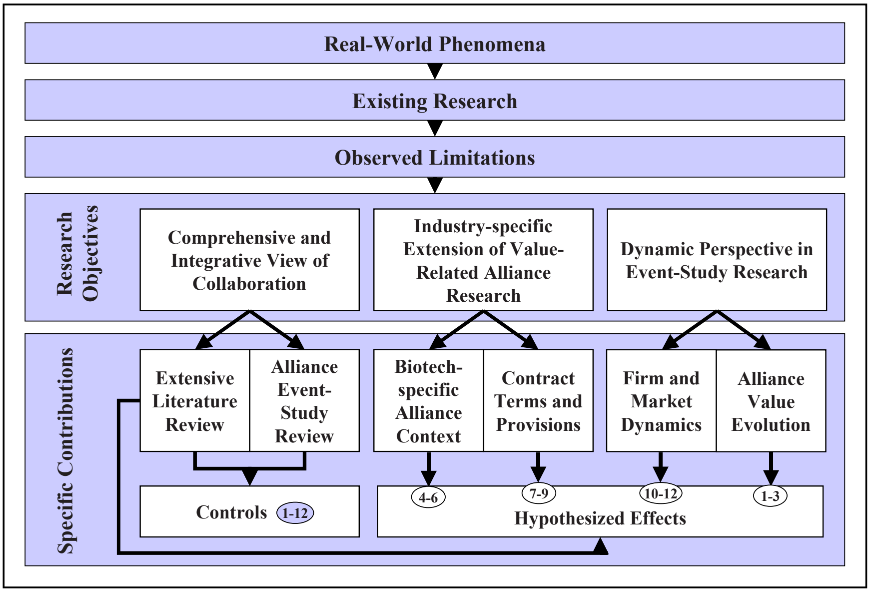
event-study evidence to the overall scope of alliance research (reflected in the propositions derived in chapter 2) identified several subareas deserving of additional research attention. Among others, the effects of information asymmetries and the contractual provisions used to contain them have so far been largely neglected. Similarly, dynamic influences on collaborative value creation have only recently been considered in event-study research [cf. (Park and Mezias 2005)]. Based on these demonstrable shortcomings and the overall research objectives, four sets of hypotheses were derived addressing collaborative value evolution (Hypotheses 1-3), biotechnology-specific transaction characteristics (Hypotheses 4-6), alliance contract constituents (Hypotheses 7-9), and dynamic influences at the environmental and firm levels (Hypotheses 10-13). Figure 42 illustrates the relationship of these contributions to the research objectives, which were derived in section 1.2.1.

Figure 42: Contributions of Dissertation Thesis



Source: Own Illustration

The empirical investigation thus focused on studying the hypotheses while accounting for the relevant controls. Overall, evidence supported 9 out of the 13 hypothesized effects regarding collaborative value creation [see Table 32 for an overview]:

- The first three hypotheses (No. 1-3) addressed the evolution of collaborative over the lifecycle of an alliance relationship and were tested using the event-study method itself. More precisely, the study applied significance tests to the ARs to alliance formation (Hypothesis 1), termination (Hypothesis 2), adaptation and progression (Hypothesis 3) announcements to assess the value impact of these lifecycle events. The results supported the hypothesized relevance of alliance formation, expansion, and milestone announcements, whereas alliance extension, modification, termination, and activities were not associated with significant announcement effects. In summary, these findings suggest that the capital market adequately anticipates many lifecycle-events at the time of alliance formation. Only substantial new developments then provoke a significant reaction during the post-formation period.

- The next three hypotheses (No. 4-6) argued that biotechnology-specific transaction characteristics have substantial valuation effects. Indeed, the business model pursued by an alliance (Hypothesis 5) and the direction of resource transfers among partners (Hypothesis 6) lead to significant variation in ARs. Moreover, these two dimensions interact with alliance stage (Hypothesis 4) and the alliance's functional objective (Control 10) to unfold a diverse picture of value creation in European biotechnology alliances. In particular, outbound alliances on drug-discovery projects in clinical trials (exploitation and further R&D activities) appear to greatly increase value.
- Another set of three hypotheses (No. 7-9) focused on the contractual features of biotechnology alliances, i.e., compensation structures (Hypothesis 7), time-limited collaboration (Hypothesis 8), and contractual flexibilities (Hypothesis 9). While compensation structure did not prove to be highly significant, it provided some evidence that DBFs may benefit from maintaining a relatively large share of the upside potential in collaborative ventures by receiving a combination of milestone and royalty payments. As incoming financial payments (including equity investments) generally are value-enhancing, this effect may be as much due to financing as incentive-alignment considerations.

  More strikingly, limited alliance duration and the presence of contractual flexibilities reduce collaborative wealth gains. Both may reflect information asymmetries between collaborators. Conversely, the actual duration of a collaborative contract is positively associated with collaborative value. All these findings support the hypothesized relevance of incentive alignment in collaborative ventures. This is of particular importance, since agency-related arguments previously were only considered with regard to prior ties between partners.
- Two hypotheses (No. 10-11) referred to market and institutional dynamics influencing the announcement returns to alliance formation. In con-

trast to Hypothesis 10, the aggregate level of collaborative activity did not significantly affect collaborative value. Competitive dynamics in the market for corporate combinations thus apparently do not expose firms to an increased pressure to collaborate. With regard to institutional dynamics more broadly, environmental uncertainty (measured as the volatility of the intra-sample stock index) exhibited an interesting pattern. Contrary to the hypothesized direction (Hypothesis 11), it significantly reduces announcement returns. In support of an option-based rationale, however, this negative net effect is due to outbound transactions, i.e., alliances in which focal firms exercise pre-existing strategic options. This implies that the common perception of alliances as providers of organizational flexibility may have to be reviewed, especially for settings, in which firms use collaboration as a means for capitalizing on internal resources.

- Finally, two hypotheses (No. 12-13) suggested that firm development may significantly affect collaborative value creation. On one hand (Hypothesis 12), the state of firm development may directly influence collaborative value creation mechanisms. Split-sample analyses generally supported the hypothesis that the specific value drivers more strongly apply to less-developed firms. On the other hand, some of the firm-development effects were expected to be mediated by (self-)selection in the decision whether to ally. Evidence rebuts this hypothesis but is supportive of contemporaneous effects of firm and environmental influences on alliance formation and value.

While all three sets of hypotheses relating to the value created by alliance formation thus yielded meaningful findings, their relative contribution to explaining announcement returns varies significantly. As demonstrated in subsection 5.3.2.4, some general observations are to be noted in this regard:

- Some aspects, such as the specific alliance context and compensation structure, possess explanatory power in isolation (i.e., when only controlling for firm-level influences), but loose this effect in the face of other transaction characteristics, such as inter-partner payments. Consequently, these dimensions may be closely interlinked, most likely with the hypothesized effects being adequately 'priced' and thus possibly at the root of variation in nominal transaction values and compensation structures.
- Other influences are additive to transaction-level factors, i.e., provide additional explanatory power irrespective of the chosen control model. Their effects may either not be correctly 'priced' (e.g., environmental dynamics) or they may serve as signals for underlying value drivers and

may have particular importance, when primary transaction characteristics are not reported initially (e.g., contractual provisions).

Table 32: Summary of Evidence on Hypothesized Effects

Hypothesis		Variable(s)/Measure(s)	Predicted Effect	Observed Effect
1	Alliance Formation	AR on Alliance Formation Announcements	+	+
2	Termination	AR on Alliance Termination Announcements	–	n.s.
3	Alliance Adaptation	AR on Alliance Extension Announcements AR on Alliance Expansion Announcements AR on Alliance Modification Announcements	+	n.s. + n.s.
	Alliance Activity	AR on Collaborative Milestone Announcements AR on Alliance Progression Announcements		+ n.s.
4	Alliance Stage	Exploitation Alliances (exploitation) Exploration Alliances (base category)	+	n.s.
5	Business Model	Drug-Discovery (m_drug) Platform Technologies (m_tech) Service Provision, Other (base category)	+ –	+ (–)
6	Direction of Resource Transfers	Outbound (d_outbound) Inbound, Joint/Cross (base category)	+	+
4-6	Joint Effect	Interaction effects (incl. R&D function)	Sign.	Sign.
7	Compensation Structure	Guaranteed Payments, receivable (guarantlong) Combination of Milestones&Royalties, receivable (mileroyallong) Others (base category)	Sign.	(+) +
8	Limited Duration	Time-duration contract (timelimited) Length of contract duration (time)	– +	– +
9	Contractual Flexibilities	Explicit contractual options (optionality)	+	–
10	Market Activity	Market Activity Index (mktactivity)	+	n.s.
11	Environmental Uncertainty	Stock-return Volatility (mktvolbt) ditto in outbound transactions (mktvolbtout)	+ –	– –
12	Firm Development	Value-creation patterns of larger and smaller (further/less developed) firms	Sign.	Sign.
13	Self-Selection	Effect of correcting for predicted probability of alliance formation	Sign.	n.s.

sign./n.s: Significant / non-significant evidence
+/–: Positively/negatively significant evidence [limited if in parentheses]

In addition to the hypothesized effects, some of the control variables show the expected impact on value creation, indicating that their inclusion is necessary to validate any observations on the hypothesized variables. Most importantly, financial payments to the focal firm (including equity investments) explain a large share of the overall variation in abnormal announcement returns. Furthermore, focal firm size, partner relatedness, partner-firm origin (both of which may also reflect partner-firm resources), and stock-market conditions fall into this category. Table 66 presents an overview of the control evidence.

Table 33: Summary of Evidence on Control Effects

	Control	Variable(s)	Predicted Effect	Observed Effect
1	Industry/Market Segment	Medical Indication Dummies (i_*)	sign.	n.s.
2	Partner Relatedness	Downstream: Pharma Partner (ptype_ph) Horizontal: Biotech Partner (ptype_bt) Upstream: University Partner (base case)	+ n.s.	+ n.s.
3	International Aspects	European Transaction Partner (pregion_eu) North American Trans. Partner (pregion_us) Japanese Transaction Partner (pregion_j) European/N. American Partner (pregion_main)	sign.	n.s. n.s. n.s. +
4	Stock-Market Climate	Return on General Market Index Return on Biotech Stock Index	– –	(–) –
5	Firm Size	Focal Firm Market Value (focalmve) Focal Firm Assets (focalassets) Focal Firm Sales (focalsales) Focal Firm Staff (focalstaff/log)	–	–
6	Partner Resources	Partner Firm Patent Endowment (pp/ppp) Partner Firm Public Status (pstatus) Partner Firm Prior Alliances (ptrans)	+	(+)
7	Alliance Experience	No. of Focal Firm Prior Alliances (experience)	+	n.s.
8	Firm Performance	Focal Firm EBIT (focalebit) Focal Firm Operating CF (focalocf) Focal Firm Total CF (focalncf) Focal Firm q (focalq)	–	n.s.
9	Prior Relations	Prior Alliance Dummy (prior)	+	n.s.
10	Transaction Function	R&D (f_rnd) Commercialization (f_commercial) Manufacturing (base case)	+	n.s.
11	Transaction Governance	License (licshort/liclong) Joint Venture (jv) Equity Investment (allequity)	+ + +	n.s. n.s. +
12	Financial Payments	Equity Investment in Focal Firm (equityshort) Equity Investment in Partner (equitylong) Payments to Focal Firm (payin) Payments to Partner (payout) Nominal Value of Inter-Partner Payments (value) Amount of Payments to Focal Firm (valuepayin) Amount of Payments to Partner (valuepayout)	+ – + – + + –	(+) n.s. (+) n.s. + + n.s.

sign./n.s: Significant / non-significant evidence
+/–: Positively/negatively significant evidence [limited if in parentheses]

While the present study primarily focused on substantive issues, it attempted to apply best-practice methods and be methodologically innovative where required. In particular, it used event-study and cross-sectional techniques similar to recent high-impact research in this field (e.g., panel-data specifications to account firm-level heterogeneity in the announcement returns). In three regards, no standard methodologies were applicable, encouraging the use of novel approaches:

- As there was no generally accepted classification of European DBFs available, the most commonly used sources were subjected to a comparative exercise [see subsection 4.1.1.2 for details]. It showed that industry-specific information providers, such as Recombinant Capital (ReCap®), provide quite comprehensive and largely congruent listings, whereas more general sources, i.e., stock-exchange registers and national industry association directories, are much less reliable. To arrive at a sample of core DBFs, the present study required firms to be included in four out of five industry-specific listings, leading to a sample of 46 firms, which tallied over 700 alliance-related news items, of which over 400 were alliance formation announcements.
- Given the single-industry, multi-country setting of the present thesis, the relative importance of general economic, industry-, and country-specific influences on stock returns needed to be considered. Since such studies are relatively uncommon,[543] no clear guidance was available from prior research. In section 4.4.2, time series regressions reveal substantial differences in the explanatory power of models incorporating these different factors. Most importantly, industry-specific influence appear to have primacy over others, but benefit from being combined into multi-factor models. Using different return-generating processes in the event-study analysis, however, shows only very little variation in the ARs across various event-windows. That is, while multi-factor modeling is theoretically warranted, its practical benefits may be limited.
- The final substantive hypothesis (13) argued that some hypothesized (or control) effects may be mediated by (self-)selection in alliance formation. This could bias the estimated significance of these influences on collaborative value. A generalized Heckman-type selection model was employed to account for these indirect effects of firm and environmental factors. Given the multiple observations per sample firm spread out across sample time, a survival-time (Cox proportional hazard) model was used to estimate the likelihood of alliance formation. The results of

[543] One notable exception are the studies by (Park and Martin 2001) and (Park 2004) on the global airline industry. As value drivers in such a setting, e.g., petrol prices, are not necessarily industry-specific, these studies use general market models or the global market model, accounting for inter-country and inter-currency differences.

the sample-selection regressions are in line with expectations (e.g., environmental munificence reducing firms propensity to collaborate). The hypothesized (self-)selection effect on value creation in strategic alliances, however, is limited.

In conclusion, this thesis paid tribute to the wealth of existing prior alliance-related research. It did so by extensively reviewing it, by incorporating its core findings as empirical control variables, and by using its methodological best practices. Additionally, the present work expanded upon existing research by considering the European biotechnology context (including biotechnology-specific transaction characteristics) and analyzing hitherto neglected aspects, such as contractual provisions and collaborative value dynamics. It also attempted to fill some methodological gaps in the empirical biotechnology and alliance arena.[544]

6.2 Limitations and Directions for Future Research

As any research, the contributions of the present thesis inevitably are limited and subject to potential shortcomings. Incompleteness and critical assumptions may be most important in this context. In addition, these limitations motivate and indicate directions for further research. Within the scope of the present study, potential shortcomings affect all three research objectives:

First, any attempt at alliance-related research is bound to be incomplete given the diversity of the topic and the sheer endless number of prior studies. Consequently, the present thesis had to reduce the extent and complexity of the incorporated information. The present study used an elaborate yet concise model to discuss and integrate the various streams of alliance research. While prior analyses have identified up to 17 different theories applied in an alliance-related context [cf. (Oliver and Ebers 1998)], five general approaches form the theoretical basis of this research.[545] Further research may be warranted to extend and refine the suggested integrative approach. Additional theories may be considered as further complements to the five main building blocks or as linking pins between them. For instance, Resource Dependence Theory [cf. (Pfeffer and Salancik 1978)]

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[544] See Table 174 in the appendix for a more detailed overview.

[545] More practically, the general literature review was limited to influential research published in leading international journals. Similarly, the review of prior alliance event studies only includes publications in the English (and in some cases French) language. To the author's best knowledge, no German language publication exists on the value impact of corporate collaboration.

may contribute to our understanding of how strategic resources (the core of the RBV) are connected to expropriation risks, transaction costs, and thus the choice of collaborative governance schemes.

Second, using the European biotechnology industry as setting limited the scope of factors that could be addressed in the empirical analysis. At the same time, the value-related evidence on biotechnology-specific alliance characteristics suggests interesting avenues for future studies. Together, these considerations define the boundaries of the present research:

- Among the different insufficiently researched aspects, some could not be adequately addressed in the present context. Issues pertaining to JV structures had to be omitted due to the infrequence of biotech collaboration taking the form of a JV. Similarly, the role of corporate governance on the value created by collaborative ventures deserves additional attention [cf. (Reuer and Ragozzino 2006)]. Given the commonly high ownership concentration and share of managerial ownership in young DBFs, such an issue should be studied in a context allowing greater variation. Some potentially interesting research topics did not conform to the present research objectives and were only addressed briefly (see Table 171 to Table 173 of the appendix).
- As indicated, biotechnology-specific transaction characteristics exhibit a diverse pattern of valuation effects. While this allows for some valuable insights, additional evidence will be required to further detail and substantiate these value mechanics. In particular, empirical analyses on these aspects were limited by the variety of available data. Using larger and possibly more specific datasets (e.g., including only drug-discovery alliances) may enable even more to-the-point conclusions. This might also allow to more effectively address the targeted medical indications, which were found insignificant but suffered from being reported infrequently. Furthermore, considering additional transaction characteristics, such as the used biopharmaceutical technologies, may be worthwhile.
- Furthermore, findings indicate a probable interrelation between transaction context, compensation structures (including the nominal value of payments), and collaborative value. In particular, compensation could or even should be endogenous, i.e., at least partially determined by the given transaction context. However, the evidence presented in this regard was limited by the availability of compensation-related information. While this problem will be common to all event-study research, more generally analyzing alliance agreements, e.g., by including privately-held firms [similar to (Coombs and Deeds 2000)], may produce deeper insights on this relationship. Alternatively, and given a sufficiently strong base of observations, structural-equation modeling may

be employed to more directly address the mediating role of intra-alliance compensation.

- While the present study provided some evidence on limited alliance duration (staging) and explicit flexibilities (contingencies), these are only some of the contractual features that may affect collaborative value creation. In other settings, more relevant contract terms may be observable at the time of alliance announcement (e.g., liability provisions in construction JVs). Additionally, the observed negative value impact of both time-limited collaboration and contractual flexibilities may represent gross effects, i.e., agency cost outweighing their benefits. Controlling for the existence of information asymmetries might allow to single out the net value of such contractual provisions.[546]

Third, while the present thesis studied dynamic value drivers on environmental, firm, and transaction levels, it could only consider a selection of influences and proxies. Consequently, the findings presented may benefit from further validation and may require fine-tuning:

- The stock-market-based measures for environmental munificence and uncertainty may sufficiently account for the general dynamics of the market environment, but less so for specific competitive dynamics. Additionally, as corporate-combination activity was not found to significantly affect collaborative value creation, alternative measures may need to be considered. Such aspects may be highly specific to the given industry context and might include changes in pricing schemes (e.g., in the airline market), technological innovation (e.g., in the electronics industry), or evolving industry structures (in all mature-stage settings). In the present context, patenting or product development may be most reflective of competitive intensity, in particular when measured for specific sub-markets (e.g., medical indications).
- The self-selection models accounting for the indirect effects of environmental and firm-level characteristics provided a methodologically sound procedure to control for oversampling biases in alliance-related research. Furthermore, the split-sample approach used to assess the direct effects of firm development yielded some surprisingly intuitive results, although the 50/50 split may be rather crude. A more fine-grained

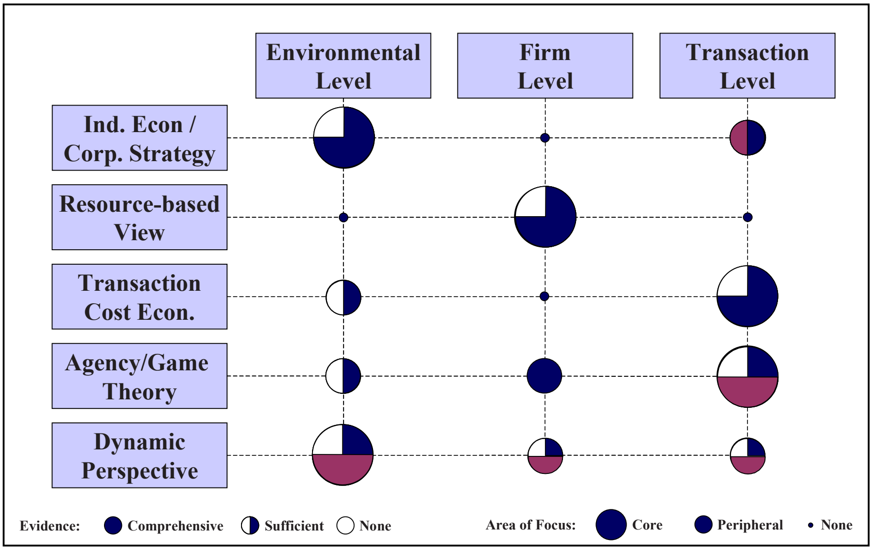
[546] On a cautionary note, in the present study, information asymmetries ought to be implicitly considered as part of the focal firm size and partner type (and origin) controls. In supplemental analyses (results not reported here) focal firm age was used as an alternative, without inducing changes in the overall findings. Similarly, neither focal firm size nor age exhibited a significant interaction with either time-limitedness or contractual options.

analysis might yield an even clearer picture of the relationship between firm development and collaborative value-creation mechanisms.

- While the event study provided a clear and consistent picture of value evolution along the alliance lifecycle, the extent of information trickling down into the market aside from such formal announcements is difficult to assess. In particular, the insignificance of alliance termination (hypothesized to be value-reducing) and extension (hypothesized to be value-enhancing) could be due to such leakage effects. A comprehensive model of collaborative value creation thus should account for both one-time AR (such as alliance formation, expansion, and milestones) as well as more continuous value development. Clearly, this is easier said than done given the general delicacy of long-term event-study research and the multitude of alliances (as well as other value-affecting events) occurring in the biotechnology industry. Clinical studies may present a starting point for identify the value dynamics in some selected alliances.

All in all, a number of gaps remain to be further researched. Figure 43 summarizes the current state of the field after considering the contributions of the present thesis. As highlighted above, research contributions (red) were centered along the environmental-level and dynamic-perspective dimensions, leaving other, rather minor shortcomings unaddressed. The documented findings thus both leave room for and give direction to further research.

Figure 43: Contributions of Dissertation to Alliance Event Study Research



Own Illustration

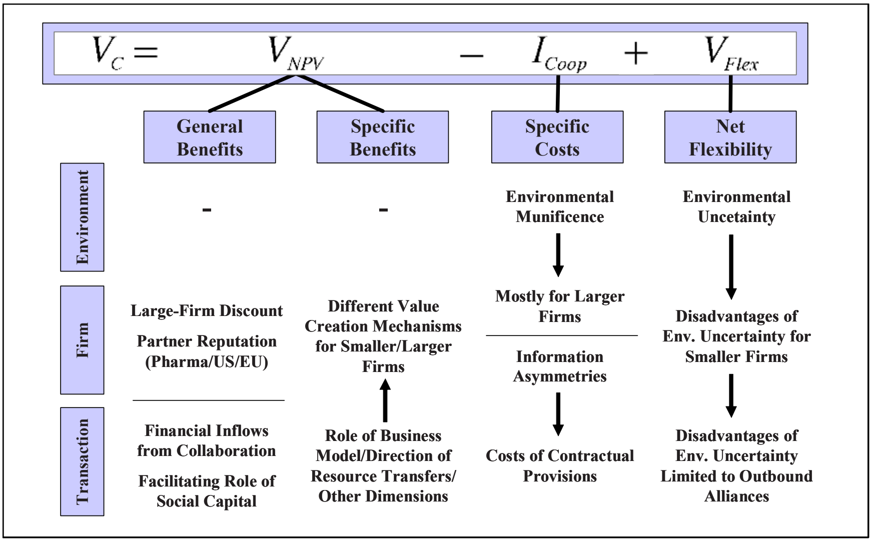
6.3 Real-World Implications

While clearly academic in nature, the research questions addressed in the present study were rooted in corporate practice. Specifically, the proliferation of alliance activity, its particular relevance for the biotechnology industry, and the dynamic changes observed in both alliance activity and the biotechnology setting gave substance to the three main research questions [see section 1.2.1].

From a real-world perspective, the contributions of this study may allow biotechnology firms and capital-market participants to better understand the underlying value drivers of biopharmaceutical collaboration. Biotechnology firms may use the findings at hand to reflect their collaborative and investor relations strategies. While prior research had focused on rather generic collaborative benefits, the present study has documented a need to consider firm- and industry-specific influences, as well as relevant costs and the net impact of strategic flexibility. Figure 44 provides a graphical overview of the different value levers.[547]

[547] Note that the general benefits in Figure 44 only comprise the statistically significant control effects.

Figure 44: Practical Implications for Collaborative Value Creation



Own Illustration

Based on the findings the present study, five main factors contribute to collaborative value creation: General alliance benefits, the choice of collaborative context, contractual provisions, and the influence of corporate as well environmental development:

- By concurrently applying several theoretical perspectives, the present study highlighted the need for researchers and practitioners to realize the multitude of possible collaborative benefits. Theoretical proposition thus may be relevant for firms' collaborative choices. For instance, in line with the concept of social capital, prior alliances may facilitate further alliance formation, which in return increases value; although they have little impact on the value added by an additional collaboration (see subsection 5.3.1.1). While not a novel conclusion, this reinforced prior findings and substantiates them for the European biotechnology setting and with regard to firm value.
- Although the evidence on biotechnology-specific alliance characteristics are quite diverse and difficult to interpret, they underscore the need for firms to pursue a convincing and well-communicated allying strategy. Most importantly, findings showed that alliances transferring resources to the partner and pursuing the drug-discovery business model yield the highest ARs (even more so if in clinical stages and involving further R&D). On one hand, European DBFs thus may benefit the most from capitalizing on their existing knowledge and resources. On the other

hand, while platform technologies and service provision may be viable business models, drug discovery remains the holy grail of the biopharmaceutical industry.

- The evidence on contractual provisions stresses the need to not only eye collaborative benefits, but also transaction and agency costs. First, firms should consider whether limiting alliance duration or fixing contractual contingencies are truly necessary, since they convey the impression that collaborators are at odds. Also, the net benefit of collaborating with a better acquainted partner or of waiting to improve one's reputation may well be positive if contractual restrictions were otherwise inevitable. At the same time, the rather similar effects of time limitedness and contractual flexibilities imply that the choice among functionally similar provisions may not be overly relevant.
- Environmental dynamics substantially affect collaborative wealth gains and thus provide managerial opportunities. In addition to the previously demonstrated effect of environmental munificence [(Park and Mezias 2005)], environmental uncertainty reduces the benefits of collaboration, in particular when proprietary resources are to be transferred to the partner (outbound direction). Consequently, if uncertainty is high, firms should try to keep all options open, rely on alternative means of refinancing, and wait to exercise their flexibilities until conditions become more favorable.
- Finally, the benefits of collaboration change with firm development. Transaction characteristics and environmental conditions differently affect the wealth gains of smaller and larger firms. Of course, any given transactions may be strategically sensible (e.g., a small firm laying the groundwork for future expansion by insourcing innovations). The overall market perception, however, as reflected in the average stock-price reaction, provides some guidance as to the capital markets' expectations. For instance, larger firms are more penalized for collaborating under munificent environmental conditions, possibly due to better alternative means of refinancing. Similarly, smaller firms are discounted more strongly when externalizing existing projects under uncertain conditions, since they may be seen as purely 'hit or miss' investments.

In summary, firms may reconsider their collaborative and investor relations strategies based on the core findings of this thesis. Investors and stock analysts may also benefit from the insights and limitations of this study by assessing whether these findings truly reflect their beliefs. At any rate, the present study has accentuated the complexity of biotechnological collaboration and consequently the need to widen the scope of potential value drivers beyond general alliance benefits.

Appendices

„Die Wissenschaft hilft uns vor allem, daß sie das Staunen,
wozu wir von Natur berufen sind, einigermaßen erleichtere;
sodann aber, daß sie dem immer gesteigerten Leben
neue Fertigkeiten erwecke zu Abwendung des Schädlichen
und Einleitung des Nutzbaren.“

Johann W. Goethe: *Maximen und Reflexionen*

Appendix to Chapter 1: Introduction and Background

Definition and Forms of Alliances

Table 34: Alternative Definitions of Strategic Alliances

Source	**Definition**
(Borys and Jemison 1989), p. 235	"Hybrids are organizational arrangements that use resources and/or governance structures from more than one existing organization."
(Buckley and Casson 1988), p. 20	"The definition of cooperation advocated here is 'coordination effected through mutual forbearance'."
(Caloghirou et al. 2003), p. 542 [similar also (Teece 1992)]	"[…] a strategic alliance (SA) is a web of agreements whereby two or more partners share the commitment to reach a common goal by pooling their resources and coordinating their activities."
(Gulati 1995b), p. 620-1 [similar also (Parkhe 1993b)]	"For this study, I defined an alliance as any voluntarily initiated interfirm cooperative agreement that involves exchange sharing, or co-development, and it can include contributions by partners of capital, technology, or firm-specific assets."
(Gulati 1998), p. 293	Alliances are "voluntary agreements between firms involving exchange, sharing, or co-development of products, technologies, or services."
(Gulati and Zajac 2000), p. 365	"For the sake of clarity, let us first define strategic alliances as voluntary arrangements between firms involving either a pooling or trading of resources."
(Kogut 1988b), p. 319	"Narrowly defined, a joint venture occurs when two or more firms pool a portion of their resources within a common legal organization."

Table 34 (Continued)

Source	**Definition**
(Parkhe 1991), p. 581	"Relatively enduring interfirm cooperative agreements, involving flows and linkages that utilize resources and/or governance schemes from autonomous organizations, for the joint accomplishment of individual goals linked to the corporate mission of each sponsoring firm."
(Spekman et al. 1998), p.748	[…] a strategic alliance is a close, long-term, mutually beneficial agreement between two or more partners in which resources, knowledge, and capabilities are shared with the objective of enhancing the competitive position of each partner.
(Madhok and Tallman 1998), p. 327	"Alliances which require a mutual and synergistic pooling of resources and capabilities and a substantial degree of commingling between partners, in terms of people, systems, skills, etc., in order to attain their objectives through sharing tacit knowledge. More than the legal form of ownership, the key issue in these collaborations is the strategic intent to combine the relevant organizational resources and capabilities of two (or more) partners in the search for a sustainable competitive advantage."

Source: Own Compilation

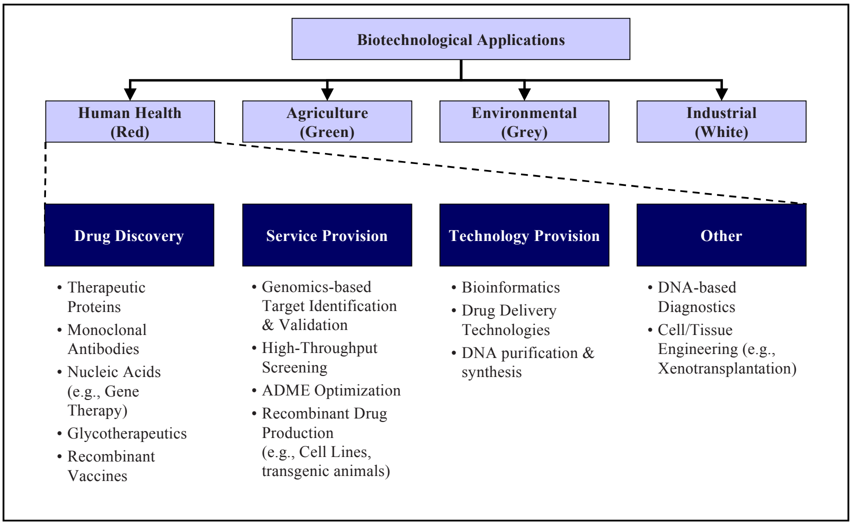
Table 35: Classification of Cooperative Modes and Organizational Interdependence

Mode of Co-operation	Organizational Interdependence
Joint Ventures and Research Corporations	Large
Joint R&D, such as research pacts and joint development agreements	
Technology exchange agreements (mutual), technology sharing, cross-licensing, mutual second sourcing	↓
	Medium
Direct Investment, Minority & Cross-Holding	
Customer-Supplier Relations, R&D contract, Co-Production, Co-Marketing,	↓
One-directional technology flow, second sourcing, licensing	Low

Source: (Hagedoorn 1990), p. 18

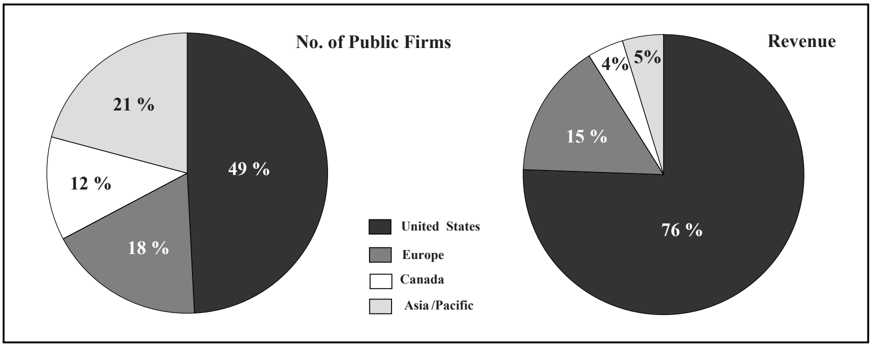
Biotechnology Industry, Firms, and Collaborations

Figure 45: Biotechnological Applications and Business Models



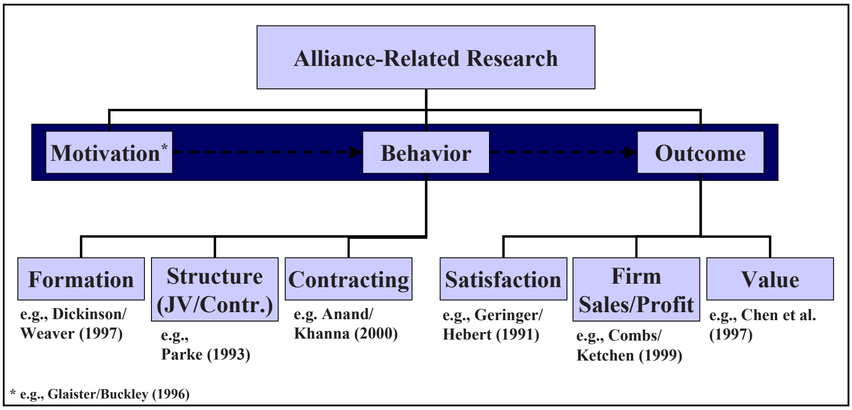
Source: Own Illustration

Figure 46: Distribution of DBFs and DBF Revenue Across Main Markets



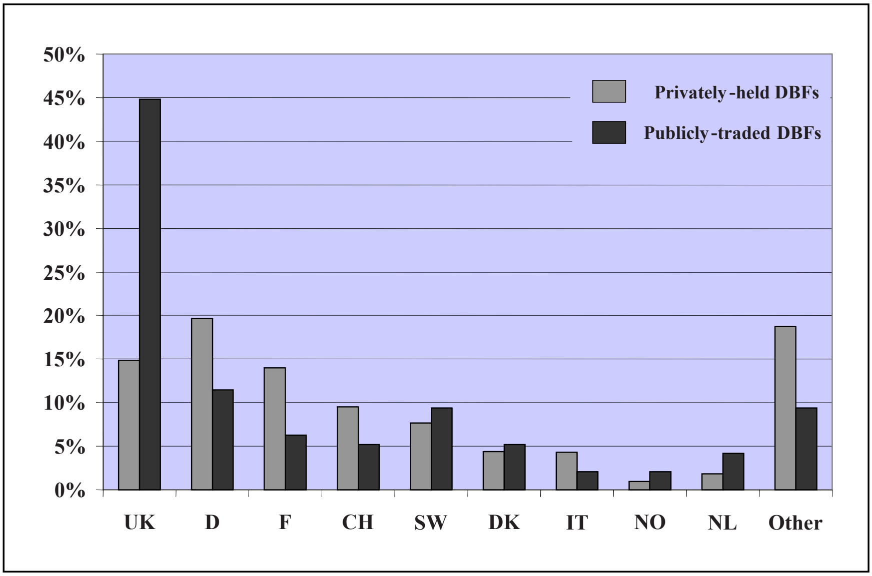
Data Source: Ernst & Young (2006)

Figure 47: Structure of Alliance-Related Research



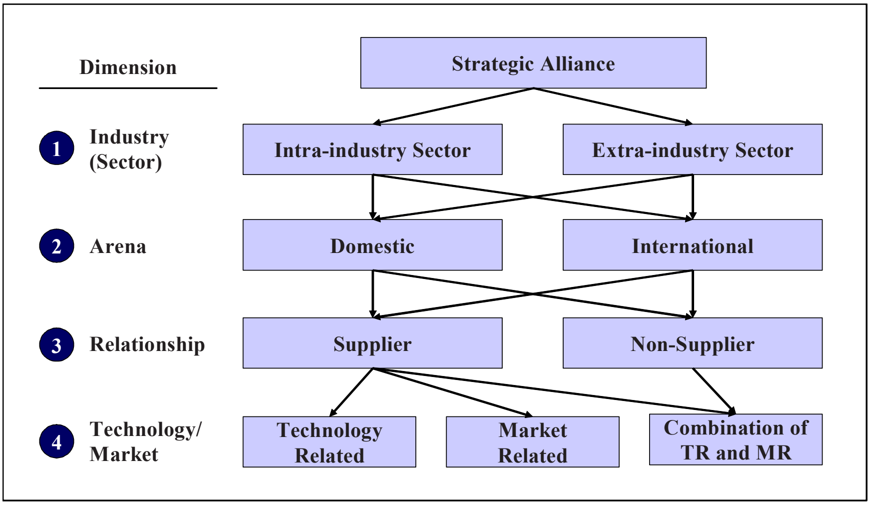
Source: Own Illustration

Figure 48: Distribution of Public and DBFs Across European Countries



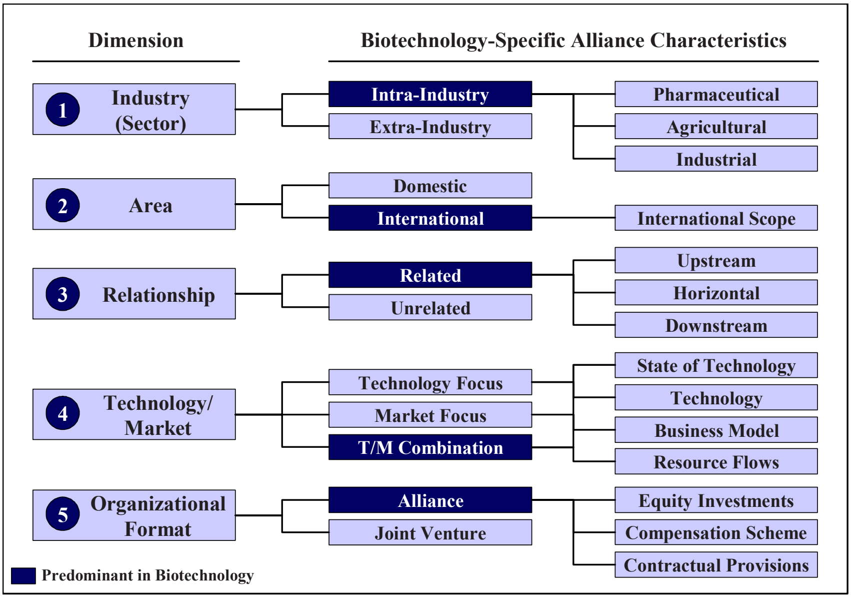
Data Sources: (EuropaBio 2005)

Figure 49: Core Dimensions of Strategic Alliances



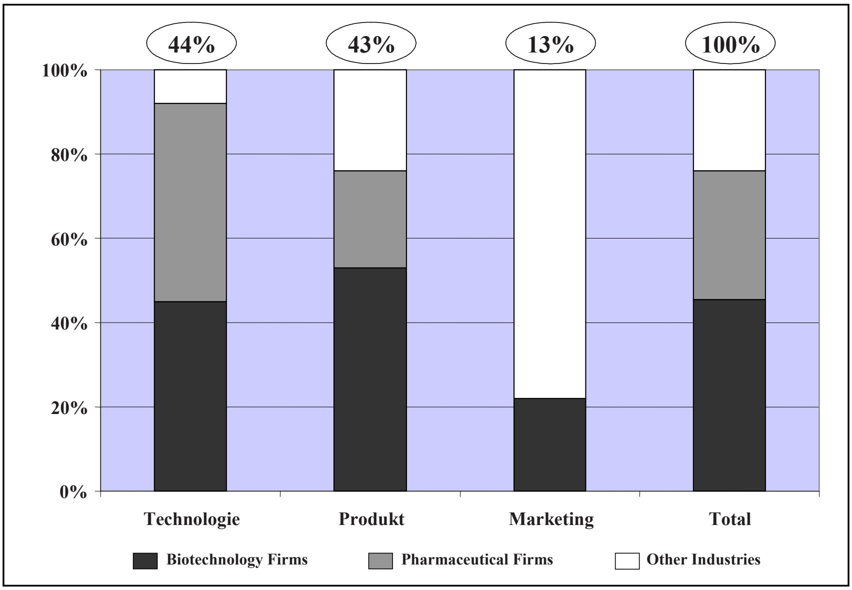
Source: Adapted from (Vyas et al. 1995) [p. 48]

Figure 50: Typology of Biotechnology Alliances



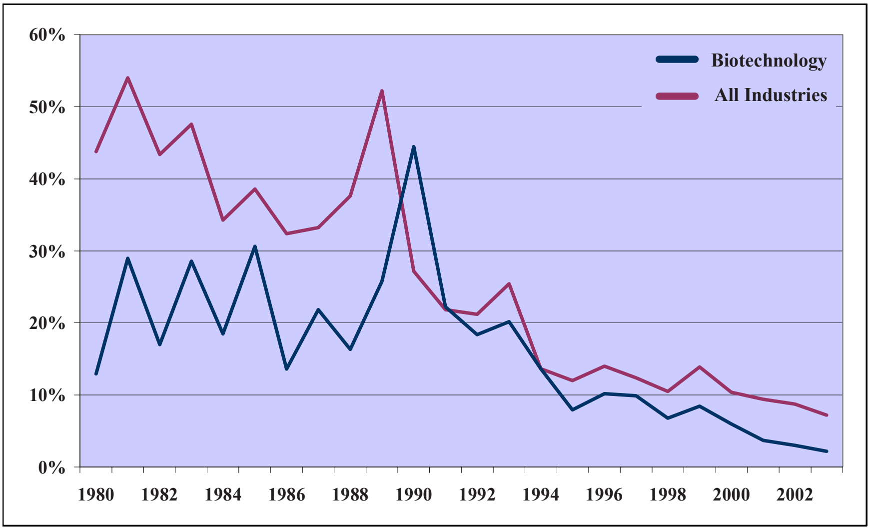
Source: Own Illustration [building on (Vyas et al. 1995)]

Figure 51: Distribution of Partner Firm Type Across Different Types of Collaboration



Data Source: (Ernst&Young 2004)

Figure 52: Share of Equity-Based Governance in Newly Formed Alliances



Data Source: (NSB 2006)

Appendix to Chapter 2: Foundations of Collaborative Value

Foundations of Alliance-Related Theories

Table 36: Overview of Prior Review Articles

Theory-Based Structure	(Barringer and Harrison 2000)	(Caloghiro et al. 2003)	Gulati/ Nohria/ Zaheer (2000)	Kogut (1988a)	Oliver (1990)	Osborn/ Hagedoorn (1997)
Industrial Economics/ Strategic Management	Strategic Choice	Mainstream Industrial Organization Shaping Competitive Environment	Industry Structure Positioning within an Industry	Strategic Behavior	Asymmetry	R&D Cooperation International Business Perspective
Resource-based View	Resource Dependence Organizational Learning	Emphasizing Resources and Capabilities	Resources and Capa-bilities	Organiza-tional Knowledge & Learning	Reciprocity	Technology and Learning Views
Transaction Cost Economics	Transaction Cost Economics	Transaction Cost Economics	Contracting and Coordination Costs	Transaction Costs	Efficiency	Transaction Costs
Agency Theory	Stakeholder Theory				Stability	
Dynamic Perspective	Institutional Theory		Dynamic networks		Legitimacy	Institution-alization

Stage-Based Structure	(Spekman et al. 1998)	(Parkhe 1993a)
Rationale	Rationale for Alliances	Motives for Formation
Alliance Formation	How to Form Alliances	Partner Selection / Characteristics
Alliance Activities	How Alliance Create Value	Control/Conflict
Alliance Termination	Sources of Tensions	
Other	Interorganizational Dynamics	Stability / Performance

Source: Own compilation

Table 37: Description of Porter's Five Forces

Intra-Industry Competition
First, intra-industry competition has traditionally been regarded as a pure matter of industry structure, i.e. the number and concentration of firms in a given market.[548] Later on, intra-industry structures and their influence on company profitability were considered as equally important. In particular, certain competitive effects may apply to entire industries, whereas others are limited to sub-segments, often referred to as "strategic groups" [cf. Porter (1979)].
New Market Entrants
Second, barriers to entry may hinder the ability of new entrants to successfully compete in a given industry and thus protect the companies currently active therein. The limited threat of new market entrants allows these established players to reap any rents available under the existent market structure, since economic profits will fail to attract additional competitors. Prior research has identified various factors serving as barriers to entry: Capital requirements, economies of scale/scope, absolute cost advantages, product differentiation, access to distribution channels, government and legal barriers as well as retaliation by established firms. [cf. Caves/Porter (1977)]
Substitute Products
Third, regarding the threat exerted by substitute products, the existence or development of sufficiently close substitutes, as well as their relative price and product quality characteristics determine the likelihood of customer switching and thus the limits to discretionary product pricing. Similar to the cases of industry rivalry and barriers to entry, substitutional relations may exist between unrelated products but also between different strategic groups in a given industry.

548 Early empirical research in industrial economics has focussed on the liaison between company size, industry concentration, or market share and company profitability [cf. Scherer (1980) for a review].

Buyer and Supplier Bargaining Power
Fourth (and fifth), and the bargaining power of buyers and suppliers may lead to economic profits realizable given industry rivalry, market entry, and substitution to be transferred up or down the value chain. It results from differences in size and market concentration, switching costs, information, and the ability to circumvent the counterpart by vertically integrating along the value chain. Similarly, the price sensitivity of demand (supply), reflecting the value attributed to a product by the buyer-side (supplier-side), limits a firm's ability to charge price premia (negotiate price reductions) otherwise imaginable given the other market characteristics. On either side, price sensitivity is influenced by competition, relative costs, and product differentiation.

Table 38: Description of Porter's Generic Strategies

Cost Leadership
Firms can realize above-normal profits by gaining cost leadership within an industry. If a firm is able to lower its costs below those of its competitors, it will be able to match or marginally underbid its competitors' prices. The firm still realizes a profit equal to the difference between its costs and the market price (presumably equal to the marginal costs of the second-least costly competitor). Similarly, such a firm will be able to better withstand the bargaining power of suppliers and customers, while new entrants and potential substitutes will be less likely to undermine its profitability.[549]
Product Differentiation
Firms may be able to set prices above the (perfect competition) equilibrium, if their product offerings are perceived as superior to its competition (differentiation), i.e. if customers obtain a higher benefit/utility from it. In this case, demand is no longer perfectly price-elastic, allowing the firm to reap economic rents. Similarly, cost pressure induced by supplier bargaining power can be handed down to customers and the danger of

[549] Note that while cost advantages may also serve as a barrier to entry (see above), cost advantages in the present context only refer to differences vis-à-vis existing competitors.

new entrants and substitutes remains limited. Such differentiation may result from product, brand, or service characteristics, among others.[550]

Niche Positioning
Firms may choose to concentrate on a niche market, where competition may be less severe and the firm may enjoy relative cost or differentiation advantages. Niche specialization may be based on a distinct customer segment (i.e. target group), a subsection of the overall industry product spectrum, or a specific geographical area.

Table 39: Characteristics of Strategic Resources

Value
First, the value of individual resources or resource bundles derives from their applicability in an otherwise competitive market. They have to enable a firm to devise and implement strategies not available to other firms. Since Barney (1991: 102) defines competitive advantage as the implementation of “value-creating strategies not simultaneously implemented by current or potential competitors”, the inherent value of resources can be viewed as the competitive advantage itself. In other words, resources are only valuable, if they enable the firm to exploit strategic opportunities or limit external threats.

Rarity
Second, while an increase in efficiency or effectiveness derived from valuable resources leads to higher welfare overall, it is not sufficient to ensure the appropriation of the value generated. If such a resource is common enough for numerous firms to exploit it in the same way, near-perfect competition will deteriorate the rents generated. While such resources may preserve the competitive status quo and thus ensure firm survival, competitive advantage requires the value-generating resource to be rare, i.e. available only to one or small number of firms.

550 In support of such differentiation arguments, empirical research has documented substantial influences of intra-industry structures. Most recently, McNamara/Deephouse/Luce (2003) find a firm’s positioning to significantly impact its performance. In particular, they show firms being part of a strategic group but remaining strategically distinct to outperform firms at the center of strategic groups as well as firms outside of such groups.

Imperfect Mobility

Third, imperfect mobility, i.e. limitations of resource transfer from one firm to another, is an inherent characteristic of many resources. Above all, three factors limit the transferability of assets among firms: (a) Many factor markets are incomplete and imperfect. Imperfect market conditions prevent the resource owner from fully appropriating the economic value of the resource [Barney (1986)]. Some resources, such as firm reputation and organizational culture, may also be untradable altogether. Rather than being acquired, firms have to accumulate or develop them over time [Dierickx/Cool (1989)]. (b) many valuable resources are attached to other resources or structurally embedded in their organizational surroundings. At the very least, the value of such resources would significantly decline with a transfer to another context [Chi (1994)]. (c) Some resources underlie effective protection mechanisms including contracts, patents, and trademarks.

Imperfect Imitability

Fourth, imperfect substitutability refers to the ability of competitors to apply other resources in using the same strategies, thus offsetting the competitive advantage derived from the proprietary resources. Provided that such substitute resources be sufficiently common, they lead to a deterioration of economic rents similar to the case of common valuable resources. On one hand, such substitutes may be very different from the valuable resources themselves. For example, Barney (1991) argues that strategic vision may be attained through charismatic leadership available only to one firm, but also through formal strategic planning processes established by many competing firms. On the other hand, substitutes may closely resemble the original resources (e.g. different management teams).

Imperfect Substitutability

Fifth, imperfect imitability applies to such close substitutes for valuable resources. Similar assets may not allow competitors to offset a firm's competitive advantage for three reasons: First, many resources are location- and time-dependent. For instance, the availability of real estate, facilities, highly qualified human capital, or corporate culture may be limited by the time of acquisition [see Barney (1991) for reference to such examples]. Clearly, resources underlying such a limitation lead to a first mover advantage as discussed by Lieberman/Montgomery (1988). Second, some valuable resources cannot be systematically created. Such socially complex attributes as interpersonal relations, company culture, or reputation may not underlie the same kind of managerial influence as physical or (to some extent) human resources [cf. Dierickx/Cool (1989)]. Third, uncertainty may exist regarding which individual attribute or which combination of attributes actually is the source of competitive advantage. This phenomenon, referred to as 'causal ambiguity', applies to both the firm enjoying the effect thereof as well as all current and potential competitors [cf. Lipman/Rumelt (1982)]. Since no firm is able to single out the valuable resource or (sometimes highly complex) interaction of resources, the advantages derived from it cannot be copied.

Table 40: Measurement of Strategic Resources

Technological Capital

In empirical research, the most often used indicator of technical capital are patent counts [e.g. (Owen-Smith and Powell 2004)], since most studies are conducted in industries, such as biotechnology [e.g. Baum/Calabrese/Silverman (2000), (Shan et al. 1994)], which heavily rely on formalized property rights [cf. (Hagedoorn and Schakenraad 1994)]. Other studies also consider quality dimensions of research output by using patent citations [(Yao and McEvily 2001)] or citation-weighted patent counts [(Sampson 2002)]. Yet other studies rely on expert ratings [e.g. (Shan 1990)] or company questionnaires [e.g. (Nicholls-Nixon and Woo 2003), (Eisenhardt and Schoonhoven 1996)] for assessing technological competence.

Specific measures of studies cited in the main text include the following:

- Ahuja (2000b) proxies important innovations as patents in the top ½ percentile of patent citation rankings in a given year. The direct effect for important innovations is statistically significant with a two-year lag, suggesting that firms having achieved such innovations tend to wait on capitalizing from them, possibly to reach better transaction terms.
- (Sakakibara 2002) uses an input-based measure of R&D capability setting the focal firm's R&D intensity (i.e., R&D to total expenditures ratio) relative to the average industry R&D intensity at the 3-digit SIC level.
- (Eisenhardt and Schoonhoven 1996) concurrently use two indicators of technological innovativeness: a self-assessment of technological strategies and an objective measure of technological advancement

(i.e., the degree of miniaturization in semiconductor circuits). Both are significant and have the predicted signs.

- (Shan 1990) ranks biotechnology firms studied from lone-stars (i.e., without competition in its segment) to distant follower based on the development (i.e., clinical) stage of all their products. The derived variable is negatively related to alliance activity and highly significant.
- (Oliver 2001) considers focal firms' product diversity at a very broad level, specifically the number of biotechnological sub-fields (therapeutic, diagnostic, agricultural, other).

Commercial Capital

In empirical research, a variety of measures have been used as proxies for different aspects of commercial capital. These include company age [(Eisenhardt and Schoonhoven 1996), (Kelley and Rice 2002)], number of employees [(Shan 1990)], sales [Stuart (2000), (Kelley and Rice 2002)], total assets [Ahuja (2000a)], stock exchange listings [(Shan et al. 1994)], and firm origin [(Yeheskel et al. 2001)].

- (Kelley and Rice 2002) measure company age at the time of IPO, which may reflect organizational legitimacy rather than commercial resources. Conversely, (Eisenhardt and Schoonhoven 1996) consider the age of the firm at the time of the alliance formation.
- More precisely, slack capital is measured based on the cash and cash-equivalent receivables positions as well as the firm's equity-to-debt ratio. (Combs and Ketchen 1999a) rely on an expert panel to assess the brand name awareness of the food services companies studied. Specific sub-criteria include respect, value-for-money, reputation for quality, and brand awareness.

Social Capital (Personal and Firm-Level)

Researchers have employed various types of personal and company-level measures of social capital. Personal measures include top-management-team (TMT) size, experience, and connectedness [e.g. (Eisenhardt and Schoonhoven 1996), (Combs and Ketchen 1999b)] as well as corporate culture [e.g. (Luo 2001), (Glaister/Buckley 1996)]. Most prominently, the number of organizational ties [e.g. (Shan et al. 1994), (Gulati 1995a), (Ahuja 2000a), (Chung et al. 2000)], partner diversity [e.g. (Gulati 1999), (Owen-Smith and Powell 2004)], and firm location [e.g. (Coombs and Deeds 2000), (Owen-Smith and Powell 2004)] are measures on the organizational level.

Other Measurement Issues

- (Simonin 1997) relies on self-assessments with regard to different dimensions of collaborative know-how. He aggregates a total of 20 measures through factor analysis to reflect collaborative management, negotiation, partner searching, knowledge & skill transfer, as well as exiting know-how. (Simonin 1997) also uses survey-based, i.e., subjective, measures of both tangible and intangible benefits. In addition, he uses as financial performance (Return on Investment/Assets) as an objective measure of tangible alliance benefits.
- (Sampson 2002) uses different measure for alliance experience: Number of all prior alliances, dummy variable, classes of 0, 1-5, 6-10, >10 alliances. Innovation performance is measured as the citation-weighted patent count over four years following formation.
- (Kale et al. 2000) operationalize the constructs conflict management, relational capital, learning, and protection of proprietary core assets using multi-item scales based on survey data from multiple industries.
- (Child and Yan 2003) utilize a joint measure of IJV growth, market share, and profitability to assess overall IJV performance. In addition to prior experience and operational learning (~ JV duration),
- (Kogut 1989) constructs scale and R&D intensiveness as interaction terms of continuous industry-level variables (i.e., minimum efficient scale and R&D-to-Expenditures) with dummy variables for JVs entailing joint production and R&D activities, respectively. Consequently, these variables reflect the relevance of the particular JV in its industry context. A similar variable, marketing intensiveness, is not significant.
- Transaction Scope: (Subramanian 2004) utilizes a composite measure of knowledge access taking into account the exclusiveness, geographical scope, and time restriction of technology licenses. This ranges from 0 (i.e., no license) to 7 (exclusive, global, and time-wise unlimited license). However, replicating the analyses for different submeasures (e.g. license vs. no license) yields strikingly similar results.
- Patent Protection: (Subramanian 2004) employs an ordered probit model distinguishing contractual alliances, equity joint ventures, and mergers & acquisitions as categories of increasing hierarchical control. In this context, (Subramanian 2004) uses secondary data to assess patent protection (on the industry level) and a measure of dispersion of the firms' patent portfolios across industry classes as indicator of patent generality. Additionally, he separately analyzes the pharmaceutical industry and finds less hierarchical ventures even after accounting for the main effects, including patent protection.

Table 41: Concept and Measurement of Network-embedded Social Capital

Conceptual Background
Social capital at the network level implies that specific network positions are associated with certain strategic advantages, i.e., network positioning is a strategic resource [cf. (Madhavan et al. 1998), among others]. As indicated in subsection 2.2.2.2, a firms' social network may be characterized along two dimensions, centrality and efficiency: As summarized by (Ahuja 2000a), central network positioning is linked to improved innovativeness, power, and reputation. The centrality of an actor in a network may be measured using different approaches [cf. (Freeman 1978/79), (Latora and Marchiori 2004)]: • centrally located actors may be directly linked to many other network constituents (degree centrality), • most closely (directly or indirectly) related to all other constituents (closeness centrality), • occupy central nodes other constituents have to rely on for communication across the network (betweenness centrality), or • contribute prominently to the overall information structure (efficiency) of the network (information centrality). While the anticipated effects of central network location are generally positive, the benefits of network efficiency may be ambiguous. On the one hand, (Coleman 1988) suggests that close-knit (i.e., efficient) networks facilitate information flows and learning. On the other hand, (Burt 1992) argues that structural holes (i.e., the absence of efficiency) allow firms to broker information and reap the corresponding private benefits. Technically, the efficiency measure is inversely related to the average distance between network constituents [cf. (Latora and Marchiori 2001)]. On a firm level, structural holes exist, if most of its ties are non-redundant, i.e., entities tied to the focal firm are not also directly linked to each other [cf. (Ahuja 2000a)]. This essentially is the inverse of networks efficiency (limited to the local network extending only up to one degree of separation).
Measurement of Network-embedded Social Capital
In alliance-related research, embeddedness or network centrality [e.g. (Gulati 1995a, 1999), (Yao and McEvily 2001), (Sakakibara 2002)] and network efficiency or the existence of structural holes [(Ahuja 2000a), Baum/Calabrese/Silverman (2000), (Yao and McEvily 2001)] are network-related variables employed in prior research:

- (Shan et al. 1994) use firm embeddedness (a measure of contribution to the network's structural equivalence similar to information centrality)
- (Madhavan et al. 1998) employ a "flow-betweenness" measure of centrality (i.e., a betweenness measure weighted by the flows of information/goods between network constituents)
- (Ahuja 2000a) devises a weighted closeness-centrality measure accounting for both the distance of indirect ties and the knowledge available from each tie
- (Tsai 2001) uses degree centrality
- (Yao and McEvily 2001) and (Owen-Smith and Powell 2004) measure network embeddedness using the betweenness concept
- (Madhavan et al. 1998) consider network centralization, a concentration measures, which is similar to network efficiency. As this approach sets firm-level centrality relative to the highest possible degree of centralization, networks with few centrally located players should be more efficient than networks with numerous equally prominent constituents.
- Baum/Calabrese/Silverman (2000) apply network efficiency
- (Ahuja 2000a) and (Yao and McEvily 2001) consider structural holes

Table 42: Background on Organizational Learning

Organizational Learning
On the most general level, organizational learning refers to all knowledge acquisition by an organization, which may in return may alter organizational behavior [cf. (Huber 1991)]. Such learning processes may take various forms. In an attempt to synthesize the organizational learning literature, (Miller 1996) distinguishes voluntary and deterministic as well as methodological and emergent types of learning. First, voluntarism of learning is constrained by existing norms and routines within organizations. At lower levels of the organization, learning thus becomes increasingly more deterministic and incremental, whereas learning by top management is rather broad and unconstrained. Second, learning may be methodical, i.e. the result of systematic analysis and based on concrete standards. Alternatively, spontaneous insights may lead to emergent learning, which is intuitive rather than explicit.[551]

[551] More specifically, (Miller 1996) identifies six types of organizational learning arising from the interaction of voluntarism/determinism and methodology/emergence dimensions. These include analytic (voluntary/methodological) and institutional (deterministic/emergent) learning as their two extremes.

Table 43: Background on Absorptive Capacity

Concept and Empirical Evidence
The first research specifically considering absorptive capacity [Cohen and Levinthal (1989, 1990)] studied differences in R&D intensity across a wide range of industry settings.[552] As factors influencing R&D intensity, they identified technological opportunity, ease of learning, and appropriability of R&D output. Specifically, they found industries being more closely related to basic than applied sciences and relying more on non-targeted extra-industry sources of knowledge (e.g. universities/government laboratories compared to suppliers/customers) to induce higher R&D spending. This reflects the increased need for absorptive capacity under such conditions. Additionally, they show appropriability to (a) have a stronger effect on R&D spending if learning was easier (i.e. applied rather than basic sciences) and firms were less interdependent (i.e. lower price elasticity). Conversely, appropriability interacts positively with industry concentration. (Cohen and Levinthal 1989) also document a significant positive main effect of appropriability on R&D intensity, which may, however, reflect the value of innovations above anything else. With regard to performance effects, (George et al. 2001) find a firm's knowledge to appropriately value external knowledge (reflected in its R&D spending) to significantly increase its market performance. (Cockburn and Henderson 1998) also show R&D spending being positively associated with the generation of important patents.[553] In direct comparison, however, the firm's prior stock of patents has an stronger, significant effect. Absorptive capacity may thus develop over longer time horizons, whereas (annualized) R&D spending only captures a part of

552 Note that this approach addresses investment in both innovation and absorptive capacity. This is in line with the model proposed by (Cohen and Levinthal 1990), arguing that proprietary R&D has a direct effect on technical knowledge as well as an indirect effect through increased absorptive capacity, which in return allows to benefit from knowledge spillovers and extraindustrial knowledge sources.

553 Additionally, (Cockburn and Henderson 1998) provide evidence of internal R&D and public collaboration being somewhat substitutive, i.e. firms investing more internally are less likely to publish collaboratively (especially with public-sector partners). Furthermore, the effects of internal R&D and public collaboration are additive, i.e. both have a significantly positive influence on R&D output. Since Cockburn/Henderson (1998), however, do not include the interaction of both effects in their analysis, it remains unclear whether their performance effects are distinct or mutually reinforcing.

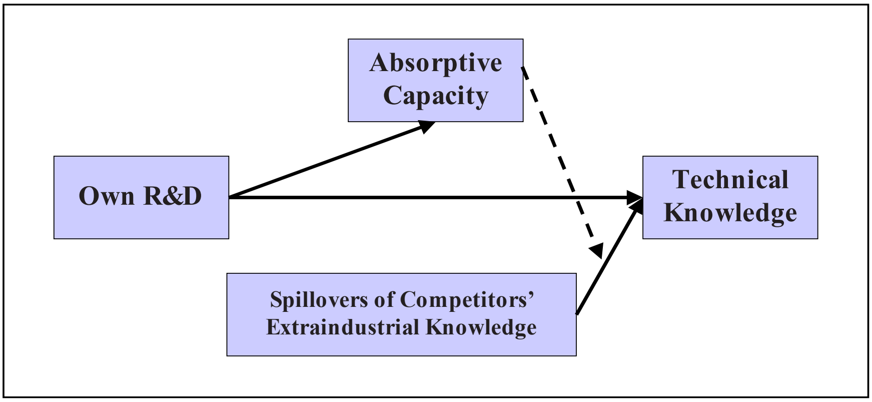
this effect. Similarly, (Stock et al. 2001) observe an inversely U-shaped effect of R&D spending on new product performance. Specifically, the returns to additional investments in absorptive capacity are insignificant or even negative at high spending levels (>12% of sales). Finally, Rothaermel/Deeds (2004) document a positive effect of broad technological knowledge (i.e., the number of technological subfields a firm operates in) on new product development.

Measurement of Absorptive Capacity

Prior research has used a variety of measures to conceptualize absorptive capacity, all relating to the focal firms' existing (technological) knowledge base. These most prominently include R&D intensity [(Cohen and Levinthal 1989, 1990), (Cockburn and Henderson 1998), (George et al. 2001), (Stock et al. 2001)], firms' patent bases [(Cockburn and Henderson 1998), (George et al. 2001)] and professional or technical personnel [(Luo 1997)].

(Lane and Lubatkin 1998) use a rather complex measure to approximate the firm's knowledge in different technological areas. Effectively, the measure reflects the overlap in both collaborating firms' publication activity across different research communities aggregated to a limited number of scientific disciplines. Along the way, it was weighted and standardized to reflect both the firm's level of involvement in given discipline and the relative importance of each discipline to the individual firm's knowledge base.

Figure 53: Function of Absorptive Capacity



Source: (Cohen and Levinthal 1990), p. 141

Table 44: Intent and Critique of Transaction Cost Economics

Transaction Cost Economics (TCE)
Standard microeconomic (i.e. neoclassical) theory assumes that market transactions take place without incurring additional costs. In this case, all exchanges of property rights would occur in the marketplace and be governed by its pricing mechanism (based on the marginal cost concept). However, if market transactions are not costless, some transactions may be cheaper to perform using intra-firm hierarchy (or inter-firm cooperation) as governance mechanism. At its core, TCE theory therefore argues that firms choose organizational arrangements that are efficient in the particular context.   In this context, a transaction represents the transfer of property rights, i.e. goods or services, from one party to another. This property-rights-based definition of transactions goes back to (Commons 1931). For a more recent and thorough discussion on the interaction of property rights and transaction-based perspectives, see (Merges 2005). Note, however, that the present work does not address property rights theory; which is a distinct branch of NIE [e.g. (Demsetz 1967)].   TCE has been widely criticized for being too one-dimensionally focused on structural cost-minimization [e.g. (Zajac and Olsen 1993)]. While TCE generally accepts that production (and other operating) costs matter as well as transaction costs,[554] it largely neglects the process of joint value maximization in collaborative ventures. Furthermore, (Ghoshal and Moran 1996) argue that hierarchical coordination functions quite distinctly from the market mechanism. Specifically, intra-organizational adaptation is driven by a common purpose rather than technical reactions to market conditions, giving hierarchies (and possibly hybrids) a purpose in excess of compensating for market failure (due to specific investments and uncertainty).[555]   These arguments primarily challenge TCE as a theory of the firm, i.e. a theory attempting to explain the existence of hierarchical organizations. For the study of inter-organizational alignments, however, they also suggest that factors outside of the standard TCE model may influence the choice market, hybrid or hierarchical structures.

554 The distinction of production and transaction costs was originally introduced by (Arrow 1969).

555 Note that the later work of Williamson [e.g. (Williamson 1991)] recognizes differences in adatation mechanisms by referring to autonomous (in markets) and coordinated adaptation (in hierachies).

Table 45: Behavioral Assumptions underlying TCE

Bounded Rationality
First, individuals are subject to bounded rationality, i.e. they are incapable to maintain perfectly rational decision making. While they intend to behave rationally, they are limited in their cognitive capacity, i.e. their ability to process and communicate information.[556] As a result, boundedly rational individuals are incapable of specifying complete contracts, which would require them to ex ante account for all future contingencies. Bounded rationality also prevents actors from comprehensively preempting, controlling for, and retaliating for breaches of contract. Contrarily, they are sufficiently capable to understand these shortcomings and to foresee the risk of becoming dependent on a transaction partner [cf. (Williamson 1991), who dubbed the term 'Farsightedness'].
Self-Interest
Second, while all individuals are assumed to be self-interested, at least some may behave opportunistically. Such behavior refers to ruthless self-interest of exchange partners, including various forms of deceit, such as selective information transfer, intentional violation of agreements etc. [cf. (Ghoshal and Moran 1996), Hill (1990)]. In the context of inter-organizational relations, the risk of partner opportunism represents the danger of being disadvantaged or expropriated, if the respective partner receives sufficient opportunity. At the same time, it may be difficult and costly, if not impossible, to ex ante verify the trustworthiness of a transaction partner [cf. Barney (1991)]. Opportunism may, however, be limited by market dynamics, if notoriously opportunistic parties are weeded out of the market and cooperative outcomes thus systematically yield higher returns [cf. Hill (1990)].[557]

556 The general notion of bounded rationality goes back to the work of (March and Simon 1958).

557 (Chiles and McMackin 1996) classify such selection arguments as one of two distinct streams of TCE ["economic natural selection"], whereas the other ["managerial choice"] relates to individual management decisions affected by transaction cost considerations. While the present work focuses on the latter approach, long-run effects such as market selection may prove helpful in explaining the frequent occurrence of collaboration. The following section on agency and game theories addresses the trust-related aspects of alliance formation. Furthermore the evolutionary perspective builds on market selection arguments.

Risk Neutrality
Third, TCE assumes actors to be risk neutral. Chiles/McMackin (1996) argue that risk preferences may alter the choice of governance mechanisms by themselves or by interacting with other behavioral traits. Specifically, more risk averse actors would tend to prefer stronger safeguards against opportunism. While risk preferences may thus affect the subjective assessment of transaction costs, they do not influence their existence or their actual (i.e. objective) extent.

Table 46: Determinants of Transaction Costs

Asset Specificity
First, assets are considered specific, if their value in alternative uses is limited (i.e. substantially lower than for their primary purpose). If assets are specific to the transaction or the transaction partner, this provides leeway for expropriation. The counterpart may effectively claim the entire difference in asset values (i.e. value of current use less highest value of an alternative use) without inducing an incentive for the asset owner to switch asset uses.[558] Alternatively, this risk of expropriation in such a lock-in situation may lead an actor to refrain from making specific investments in the first place, thus creating a 'lock-in' situation [cf. Williamson (1985)].   Specific investments are necessary for creating value, or for that matter maximizing total welfare [cf. (Amit and Schoemaker 1993)]. Consequently, they may also have a bonding effect limiting opportunistic behavior [cf. Heide/John (1988)]. Transaction partners may at least partially abstain from expropriation in order to ensure that specific investments are undertaken and reciprocal investments in relationship-specific assets will have a similar effect. However, adaptation of contractual terms will always be hindered by asset specificity. Consequently, TCE argues that transactions associated will medium and high levels of asset specificity are most efficiently organized under hybrid and hierarchical governance schemes, respectively. The market mechanism only suffices for low asset-specificity transactions.

558 These "quasi-rents" [term going back to (Marshall 1893)] lead to a small numbers bargaining problem, since the owner of specific assets is rather committed to the transaction partner. This focus on asset specificity represents a later amendment by Williamson (1985) and others. Contrarily, earlier work [such as Williamson (1975)] addressed only small numbers bargaining in general.

Environmental Uncertainty

Second, an uncertain environment may more frequently necessitate adaptations of transaction structures (e.g. contracts) unless these were comprehensively specified in the first place. Provided that asset specificity is non-negligible, altering the transaction governance scheme will incur additional costs for at least two reasons. On one hand, the transaction amendment itself is costly, e.g. due to renegotiation costs. On the other hand, the need for adaptation may be opportunity abused by the transaction partner, depending on the current relative bargaining power. Conversely, adaptation more frequently required in uncertain environments is costless if assets are non-specific. Therefore, uncertainty increases transaction costs, but this effect is conditional on the presence of asset specificity.

Similar to the case of specific assets, this leads to hybrid and hierarchical forms of governance becoming increasingly preferable under conditions of medium or high uncertainty. However, (Williamson 1991) argues that the advantages of hybrid transactions in very uncertain environments are more than offset by the complications caused by bilateral decision making, whereas both markets and hierarchies allow firms to act autonomously. As a result, hierarchies (and markets) may be more efficient for high-uncertainty transactions, even in the case of intermediate levels of asset specificity.

Transaction Frequency

Third, more frequent (i.e. recurrent) transactions may be more efficiently governed internally, since the costs of hierarchical coordination are largely fixed and thus digress with repeated transactions. Alternatively, such transactions would need to be monitored continuously in market-based transactions, incurring substantial transaction costs. Similar to uncertainty, the effect of transaction frequency is contingent on the existence of specific assets. Consequently, increasing levels of transaction frequency render (first) hybrid and (then) hierarchical governance more efficient than market transactions [cf. Williamson (1985)].

Table 47: Types of Information Asymmetry

Hidden Information
Ex ante information asymmetries [Arrow (1985) utilizes the term “hidden information”] induce an “adverse selection” problem. Assuming that the principal is unable to accurately value the agent’s products or services, she is unable to separate “good” agents (i.e. deserving of higher prices) from “bad” agents (i.e. undeserving of higher prices). Accordingly, she may have to assume all agents being “bad agents” and may only offer to pay a relatively low price (or level of compensation). In face of low compensation, only “bad” agents will, however, be willing to accept the offered contract, leading to a sub-optimal outcome for both principal and agent [known as the “market for lemons” problem presented by (Akerlof 1970)]. Prior academic literature has proposed three mechanisms to resolve hidden information problems: First, the principal may attempt to differentiate “good” from “bad” agents by engaging in a screening process. Second, “good” agents may attempt to signal their higher quality type by engaging in activities too costly for “bad” agents to imitate. Third, the principal may provide agents with a self-selection mechanism, i.e. a contract offer only “good” agents will accept.
Hidden Action
Ex post information asymmetry leads to a different kind of agency problem, known as “moral hazard” [(Arrow 1985) dubbed this “hidden action”]. As both principals and agents are self-interested, agents will pursue their individual goals rather the ones of the principal, if they do not have to fear rebuttal. Principals will, however, rarely be able to judge the agents’ effort or performance, because one (effort) is largely unobservable without incurring prohibitive costs and the other (performance) is heavily influenced by external factor beyond the agents’ influence. Two mechanisms may relieve these “moral hazard” problems. First, principals may attempt to monitor their agents. Second, contracts may be specified in a way to align the agents’ incentives with the principals’ interests.

Table 48: Background on Evolution

Evolution in Economics and Business
Economic evolution refers to the biological principles of variation, heredity and selection. Evolutionary arguments have been advanced indicating that product market activities and organizational capabilities are closely linked. More specifically, firm activity is targeted at creating distinct capabilities (variation) based on existing and emerging routines (heredity) in order to succeed in face of market selection [cf. (Nelson and Winter 1982)]. Similarly, market developments (in technology, customer demands, or the competitive landscape) induce firms to adapt, i.e. firms and markets (macro) co-evolve, as do (micro) different sub-systems within a given firms [cf. (McKelvey 1997)]. (Van de Ven and Poole 1995) characterize evolution as prescribed patterns of change affecting entire populations (i.e. multiple entities). Co-evolution on the macro level thus results from corporate initiatives and market selection regarding technologies and product offerings. Collaborative ventures may be one strategy pursued by firms in order to withstand market selection. As a result, network formation may represent a reaction to environmental requirements or stimuli. While too broad to be discussed here in detail, dynamic models may differ with regard to their unit of focus (single versus multiple entities) as well as to proposed mode of change (prescribed, i.e., following a generic pattern, or constructive. Prior research on the dynamics collaborative agreements usually has focused on prescribed patterns of industry evolution as well as company and/or alliance life-cycles. See (Von Schroeter 2004) for details.

Table 49: Constituting Characteristics of Real Options

Real Options
Following general real option literature [e.g., (Trigeorgis 1996), (Copeland and Antikarov 2001)], investments have option value in addition to their (expected) net present value, if they possess three main characteristics: • Flexibility: Financial Options entail rights but not obligations. Analogous, management may react upon additional information, if this increases firm value. Consequently, real options represent different types of flexibilities (e.g., to defer actions, to expand or shut down operations)

- Uncertainty:
  The future value of a financial option's underlying is stochastic. Similarly, corporate activity generally is subject to uncertainty [see (Courtney 2001) for a typology ranging from continuously quantifiable risk to true ambiguity]. In particular, the possibility of reacting to future developments (flexibility) is only valuable under conditions of uncertainty, i.e., if value-related information becomes available over time.
- Irreversibility:
  Exercising financial options requires payment of the exercise price and results in the termination of the option right. In the case of real options, reacting to the resolution of uncertainty usually necessitate irreversible investments (e.g., in production or marketing capacities), which reduces future flexibility.

Summary of Theoretical Foundations

Table 50: Overview of Propositions

Propositions	
Industrial Economics and Corporate Strategy	
Reasoning 1:	Alliances create firm value by reducing competitive price pressure on a firm together with or at the expense of its competitors.
Proposition 1.1:	Alliances create firm value by increasing market power, especially in quite concentrated industries.
Proposition 1.2:	Alliances create firm value by rectifying R&D incentives in situations of competitive R&D (patent races) or limited appropriability of R&D results (spillovers).
Proposition 1.3:	Alliances create firm value by allowing entry into markets protected from full-scale competition, which would not be accessible in isolation.
Proposition 1.4:	Alliances create firm value by enabling first mover advantages through accelerated market entry.
Proposition 1.5:	Alliances create firm value by generating strategic cost and/or differentiation advantages vis-à-vis competitors in existing markets.

Table 50 (Continued)

Resource-Based and Learning Theories	
Reasoning 2:	Collaborative value creation is based on complementary strategic resources, which foster alliance formation, joint development of additional resources, and alliance performance.
Proposition 2.1:	Collaborative value creation is linked to the extent and complementarity of technological resources.
Proposition 2.2:	Collaborative value creation is linked to focal firms' commercial capital, which facilitates alliance formation, and the complementarity of partner resources (including technological capital).
Proposition 2.3a:	Collaborative value creation is linked to personal social capital, which facilitates alliance formation and, at the dyadic level, improves alliance performance.
Proposition 2.3b:	Collaborative value creation is linked to organizational social capital, which facilitates the formation of new linkages and provides additional substantive benefits.
Proposition 2.3c:	Collaborative value creation is linked to the social capital of network embeddedness, which generates additional alliance opportunities and substantively affects resource development and commercial performance.
Proposition 2.4:	Collaborative value creation is linked to the collaborative competence resulting from alliance experience, which allows firms to manage alliances and collaborate more effectively.
Proposition 2.5:	Collaborative value creation is linked to absorptive capacity. The latter facilitates learning from collaborative contacts, as long as partner knowledge remains sufficiently dissimilar to provide room for learning.

Table 50 (Continued)

Transaction Cost Economics	
Reasoning 3:	The appropriation of collaborative value requires efficient choices of hybrid (over hierarchical and market-based) transaction governance and contractual or equity-based collaboration, i.e., minimizing transaction costs in a given context.
Proposition 3.1a:	The appropriation of collaborative value requires more restrictive (equity-based) hybrid governance, when agreements address R&D activities; in particular, if projects are strategically important.
Proposition 3.1b:	The appropriation of collaborative value requires more restrictive (equity-based) hybrid governance, when asset specificity creates expropriation risks, unless investments are bilateral and/or knowledge relatedness is limited.
Proposition 3.2:	The appropriation of collaborative value requires more flexible (contractual) hybrid governance in technologically uncertain environments.
Proposition 3.3:	The appropriation of collaborative value requires matching choices of narrow or broad transaction scope and contractual or equity-based hybrid governance, respectively.
Proposition 3.4a:	The appropriation of value from international market entry requires less flexible (hybrid) transaction governance given prior international experience and host-country presence.
Proposition 3.4b:	The appropriation of collaborative value is linked to firm experience in the given governance mode and (in the absence thereof) to successful precedents of other firms in similar contexts.

Table 50 (Continued)

Agency and Game Theories	
Reasoning 4:	Information Asymmetries may hamper collaborative value creation unless specific measures mitigate them or align principal and agent objectives.
Proposition 4.1a:	Information asymmetries between management and shareholders reduce collaborative value creation, since alliances may yield private managerial rather than shareholder benefits.
Proposition 4.1b:	Information asymmetries between focal firms and capital markets com- pound collaborative value creation, since partner reputation serves as a signal for unobservable firm quality.
Proposition 4.2:	Information asymmetries between collaborating parties reduce collaborative value creation by hindering principals' ability to adequately value (and compensate) agents ' contributions.
Proposition 4.3a:	If information asymmetries create economically important expropriation risks, full collaborative value creation and appropriation requires more extensive and explicitly specified alliance contracts.
Proposition 4.3b:	Environmental uncertainty may render explicit contractual provisions ineffective and require the use of contingent control rights to assure value appropriation.
Proposition 4.4a:	Trust arising from long contract duration and prior interactions allows realizing collaborative value without resorting to costly governance schemes.
Proposition 4.4b:	Inter-partner trust may assure value appropriation through better specified contractual statutes and a reduced need for ongoing monitoring and control.
Proposition 4.5:	Effective patent protection may enable the appropriation of collaborative value without incurring the costs of more restrictive governance.

Table 50 (Continued)

Dynamic Perspectives	
Proposition 5.1a:	Alliances create firm value by positioning firms in industry networks, which may alleviate competitive disadvantages and unfavorable environmental conditions.
Proposition 5.1b:	Alliances create firm value by helping firms reach or maintain favorable positions in reconfiguring networks.
Proposition 5.2:	Alliances create firm value by providing strategic flexibility, in particular under conditions of high environmental uncertainty.
Proposition 5.3:	The value of strategic alliances is smaller for further developed firms.
Proposition 5.4:	Alliances create firm value by contributing to the exploration and exploitation of strategic resources in line with the evolving organizational development needs of focal firms.
Proposition 5.5a:	Modification of existing alliance creates collaborative value by realigning the collaboration to contextual requirements, with value appropriation depending on the collaborating firms' relative bargaining power.
Proposition 5.5b:	Alliance termination reduces collaborative value by eliminating collaborative benefits in reaction to insufficient performance and/or excessive rivalry among partners.
Proposition 5.5c:	Alliance internalization creates firm value by monopolizing collaborative benefits in reaction to the successful progression of activities.

Appendix to Chapter 3: Value Impact of Collaboration

Overview of Prior Event Studies

Table 51: Strategic Alliance & Joint Venture (Event Study) Data Sets

Authors (Year)	Observa-tions	Treatment	Sam-pling Period	Sample Size	Indus-try/-ies	Coun-tries	AR (Day 0)
(McConnell and Nantell 1985)	Joint ven-tures (JVs)	Equally-weighted portfolios	1972-1979	136	Various	U.S.	+0.73%*** (a)
(Ravichandran and Sa-Aadu 1988)	JVs	---	1972-1983	59	Real Estate	U.S.	+0.31%**
(Lee and Wyatt 1990)	Interna-tional Joint Ventures (IJV)	N/A	1974-1986	109	Various	U.S.	-0.47%*
(Woolridge and Snow 1990)	JVs	---	1972-1987	767	Various	U.S.	+0.38%**
(Chen et al. 1991)	IJVs	N/A	1979-1990	88	Various	U.S.	+0.52%**
(Crutchley et al. 1991)	IJVs	N/A	06/1979-06/1987	146	Various	U.S./ Japan	+1.05%*** (a) / +1.08%* (a)
(Koh and Venkatraman 1991)	JVs (other co-operation)	Separate events	1972-1986	175 (196)	Informa-tion Technol-ogy	U.S.	+0.87%*** (a)
(Hu et al. 1992)	IJVs	N/A	1983-1989	42	Various	U.S.	0.07/0.26% n.s.
(Balakrishnan and Koza 1993)	JVs (M&A)	Separate events	1974-1977	64 (165)	Various	U.S.	+1.19%*** (a)
(Cordeiro 1993)	JVs	---	1988	106	Various	U.S.	+1.21% n/a
(Chung et al. 1993)	IJVs	N/A	1969-1989	230	Various	U.S.	-0.16% n.s.

//* significant at 1%/5%/10%-levels n.s. not significant
(a) smallest available event window (no day 0 returns reported)

Table 51 (Continued: 1994-2000)

Authors (Year)	Observa-tions	Treatment	Sam-pling Period	Sample Size	Indus-try/-ies	Coun-tries	AR (Day 0)
(He et al. 1994)	JVs/IJVs	---	1975-1990	59	Real Estate	U.S.	-0.06% n.s.
(Madhavan and Prescott 1995)	JVs	Only one parent	1978-1991	108	Various	U.S.	-0.42/+2.87%
(Mohanram and Nanda 1996)	JVs	Separate events and value-weighted	1986-1993	196	Various	U.S.	+0.87%** (a)
(Chan et al. 1997)	Alliances	Value-weighted	1983-1992	345	Various	U.S.	+0.64%***
(Park and Kim 1997)	JVs	Only one parent	1979-1988	158	Electron-ics	U.S.	+0.76%***
(Reuer and Miller 1997)	IJV Inter-nalization	"Acquirer" only	1988-1994	88	Various	U.S.	-0.06% n.s.
(Das et al. 1998)	(Two-party) Alliances	Separate events	1987-1991	119	Various	U.S.	+0.50%**
(Fröhls 1998)	IJVs	N/A	1987-1992	320	Various	U.S.	+0.75%***
(Wu and Wei 1998)	Collabora-tive R&D Projects (Termina-tions)	Equally weighted Portfolios	1985-1992	105 (11)	Various	U.S.	+0.89%** (-1.26% n.s.)
(Irwanto et al. 1999)	IJVs	N/A	1990-1995	300	Various	U.S.	+0.08%*
(Anand and Khanna 2000a)	Licenses / JVs	Separate events	1990-1993	1106 / 870	Manufac-turing	U.S.	+1.42%** / +0.67%**
(Houston and Johnson 2000)	Vertical JVs / Buyer-supplier contracts	Equally weighted Portfolios	1993-1994	42 (166)	Various	U.S.	+1.52%** / +0.21% n.s. to +2.47%**

****/**/* – significant at 1%/5%/10%-levels n.s. – not significant
(a) – smallest available event window (no day 0 returns reported)

Table 51 (Continued: 2000-2001)

Authors (Year)	Observa-tions	Treatment	Sam-pling Period	Sample Size	Indus-try/-ies	Coun-tries	AR (Day 0)
(Johnson and Houston 2000)	Vertical JVs/Buyer-supplier contracts	Equally weighted / Separate Events	1991-1995	119 (215)	Various	U.S.	+1.67%*** / -0.08%n.s. to +1.54%***
(Reuer and Koza 2000a)	JVs (bilateral, terminated)	---	1985-1995	297	Various	U.S.	+0.44%**
(Chen et al. 2000)	IJVs	N/A	1979-1993	174	Various	Singa-pore	+0.96%***
(Gupta and Misra 2000)	IJVs	N/A	1979-1992	532	Various	U.S.	+0.06 n.s. (a)
(Merchant and Schendel 2000)	IJVs	N/A	1986-1990	393	Manufac-turing Sector	U.S.	+0.70%*
(Rajgopal et al. 2000)	Techology/ Marketing/ Distribu-tion Alli-ances	Separate Events	04-09/2000	412 / 121 / 116	Internet (B2B)	U.S.	+0.6%*** (a) +2.3%*** (a) +1.6%*** (a)
(Reuer 2000)	IJVs/ IJV Termi-nation	N/A	1985-1990	214	Various	U.S.	+0.39%**/ +0.01%n.s.
(Reuer 2001)	JV Interna-lization/ Termination		1985-1995	215	Various	U.S.	
(Ueng et al. 2000)	IJVs	N/A	1990-1995	235	Various	U.S.	-0.06%n.s.
(Gulati and Wang 2001)	JVs (bilateral)	Equally-weighted portfolio	1987-1996	658	Various	U.S.	+0.01% n/a
(Park and Martin 2001)	Alliances		1986-1998	225	Airlines	Various	+1.07%*** (a)
(Neill et al. 2001)	(R&D) Alliances	---	1987-1994	(89 firms)	Informa-tion Technol-ogy	U.S.	+0.57%**

***/**/* – significant at 1%/5%/10%-levels n.s. – not significant
(a) – smallest available event window (no day 0 returns reported)

Table 51 (Continued: 2001-2003)

Authors (Year)	**Observa-tions**	**Treatment**	**Sam-pling Period**	**Sample Size**	**Indus-try/-ies**	**Coun-tries**	**AR (Day 0)**
(Reuer 2001)	JV Inter-nalization	"Acquirer" only	1985-1995	139	Various	U.S.	n.s.
(Bayona et al. 2002a, 2002b)	(Strategic Technol-ogy) Alli-ances	---	1997-2000	120	Various	Spain	+0.03% n.s.
(Chang and Kuo 2002)	Alliances	Separate Events	1997-2000	137	Various	Taiwan	+0.87%***
(Kale et al. 2001, 2002)	Alliances	Separate events		1572	Various	U.S.	Not Reported
(Karamanos 2002)	Alliances	---	1992 – 1999	209	Biophar-maceuti-cals and Diagnos-tics	UK	+4.30%***
(Kim and Park 2002)	(Interna-tional) Alliances	Separate events	1993-1997	146	Various	Various	+0.42%***
(Merchant 2002)	IJVs	See Mer-chant/ Schendel (2000)	---	---	---	---	---
(Meschi and Cheng 2002)	IJVs	N/A	1998-2001	68	Various	Europe	-0.17% n.s.
(Schut and Van Fredrikslust 2002)	JVs	Separate events	1987-1998	233	Various	Nether-lands	+0.40%*** (a)
(Yao and Ge 2002)	(R&D) alliances	---	1989-1998	(68 firms)	Various	---	Not Reported
(Campart and Pfister 2003)	Alliances/ JVs	---	1995 – 2000	237	Pharma-ceuticals / Bio-technol-ogy	U.S.	+3.91%*** (a) / +3.92%*** (a)

***/**/* – significant at 1%/5%/10%-levels n.s. – not significant
(a) – smallest available event window (no day 0 returns reported)

Table 51 (Continued: 2003-2004)

Authors (Year)	Observations	Treatment	Sampling Period	Sample Size	Industry/-ies	Countries	AR (Day 0)
(Gleason et al. 2003)	Alliances	Separate Events		728 (638 transactions)	Financial Services	U.S.	+0.51%*** (a)
(Hanvanich et al. 2003)	IJVs	N/A	1997-1999	1015	Various	U.S.	+0.57%*** (a)
(Houston 2003)	Bank loan announcements	---	[1990s]	222	Pharmaceuticals/ Biotechnology	U.S.	+1.18%*** (a)
(Merchant 2003)	JVs	---		272	Various	U.S. ⇔ Asia	Not Reported
(Sleuwaegen et al. 2003)	(International) Alliances	---	1985-1992	105	Various	Netherlands	-3.65%* to +2.00%*
(Vidal Suarez and García-Canal 2003)	(International) Alliances	---	1987-1997	72	Various	Spain	+0.19%**
(Arend 2004)	Alliances	---	1985-1994	96	Computing	U.S.	N/A
(Brooke and Oliver 2004)	Alliances	---		123	Various	Australia	+1.40%***
(Chang et al. 2004)	Alliances/ Effect on Rivals	Separate Events/ Equally-weighted	1990-2000	1133	Various	U.S.	+0.45%*** / -0.27%***
(Jones and Danbolt 2004)	JVs	---	09/1991 – 09/1996	158	Various	UK	+0.50%***
(Meschi 2004)	IJVs		1994-2002	67	Various	France ⇔ China	-0.14% n.s.
(Park 2004)	Alliances	Separate Events	1986-1998	241	Airlines	Various	+0.92%***
(Park et al. 2004)	Alliances	---	2001	272	E-commerce	U.S.	+1.49%***
(Piachaud and Muresan 2004)	Alliances/ JVs	Separate events	1994-1999	58 / 93	Manufacturing	UK	+0.23% n.s./ +0.29% n.s.

***/**/* – significant at 1%/5%/10%-levels n.s. – not significant
(a) – smallest available event window (no day 0 returns reported)

Table 51 (Continued: 2004-present)

Authors (Year)	Observations	Treatment	Sampling Period	Sample Size	Industry/-ies	Countries	AR (Day 0)
(Wang and Wu 2004)	Alliances	Separate Events	1996-1999	158	Electronics	Taiwan	+0.65%***
(Burton 2005)	Alliances (incl. Supply-Contracts)	---	1993-1995	947	Various	UK	+1.55%** (a)
(Chiou and White 2005)	Alliances	Equally weighted portfolios	1997-1999	109 (169 Firms)	Financial Services (all partners)	Japan	+2.93%***
(Hanvanich et al. 2005)	JVs	---	1997-1999	868	Various	U.S.	+0.55%
(Häussler 2005, 2006) [also (Socher 2004)]	Alliances / Termination	---	1997-2002	1037	Various	Germany	+3.90%*** / -4.20%***
(Huang and Chan 2005)	Alliances	---	1996-2000	140	Various	Taiwan	+1.34%*** (a)
(Meschi 2005)	JV Sell-Offs	Separate Events	1994-2002	151	Various	Europe	+0.65%* (a)
(Park and Mezias 2005)	Alliances	---	1995-2001	408 (75 firms)	E-commerce	U.S.	+2.62%*** (a)
(Sánchez-Lorda and García-Canal 2005)	Alliances		1986-2001	372	Telecommunications	Europe	-0.02% n.s.
(Higgins 2006)	Alliances	---	1993-2000	153	Pharmaceutical /Biotechnology	U.S.	+1.06%**
Subramaniana/ Gondhalekara/Narayanaswamy (2006)	Alliances	---	1996-2003	200	Various	U.S.	+2.48%*
Suresh/Thenmozhi/ Vijayaraghavan (2006)	Various Corporate Events	---	01/2004 - 05/2005	474 (thereof 17 JVs / 37 Alliances)	Various	India	Not reported*
(Meschi et al. Undated)	International Joint Ventures	N/A	1994-2000	47	Various	France ⇔ China	N/a

***/**/* – significant at 1%/5%/10%-levels n.s. – not significant

(a) – smallest available event window (no day 0 returns reported)

Table 52: Other Value-Related Alliance Research Data Sets

Authors (Year)	**Observations**	**Treatment**	**Sampling Period**	**Sample Size**	**Industry/-ies**	**Countries**	**AR (Day 0)**
(Stuart et al. 1999)	IPOs	N/A	1987-1991	301	Biotechnology	U.S.	N/A
(Allen and Phillips 2000)	Block purchases		1982-1991	402	Various	U.S.	
(Nicholson et al. 2002)	Venture capital financing / IPOs		1991-2000	539	Pharma/ Biotech	U.S.	
(Gulati and Higgins 2003)	IPOs		1979-1996	299	Biotechnology	U.S.	
(Janney and Folta 2003)	Private equity placements		1973-1998	695	Biotechnology	U.S.	
(Chang 2004)	IPOs			90 IPOs (1106 firms)	e-Commerce / Internet Portal	U.S.	
(Folta and Janney 2004)	Private Equity Placements / SPOs		1973 – 1998	780 / 346 (328 firms)	Biotechnology	U.S.	
(Hand 2004)	VC Financing & Stock Market Returns		1992-2003	481 / 289	Biotechnology	U.S.	
(Arend and Amit 2005)	Firm Market Value		1989-1993	620	Computing	U.S.	

***/**/* (a) – smallest available event window (2 days – 1 month)

Table 53: Value Impact of Mergers and Acquisitions

Overall Value Impact of Mergers & Acquisitions (M&A)
Mergers and acquisitions may be strategically similar to alliances and joint ventures. However, they underlie higher complexity, including the distinction of bidder and target firms. At the same time, specific takeover regulation and defenses have an influence on value creation. Therefore, while addressing most areas of relevance, the following summary refers only to a subset of all event studies, dating back to (Mandelker 1974). For a more comprehensive picture, event study research on corporate acquisitions has previously been reviewed by (Jensen and Ruback 1983), (Jarrell et al. 1988), and (Bruner 2002), among others. Complementarily, (Agrawal and Jaffe 1999) provide a review of empirical work regarding long-run stock returns following M&A transactions. Recent evidence on M&A value impact include Eckbo/Thornburn (2000), (Kohers and Kohers 2000), Walker (2000), Andrade/Mitchell/ Stafford (2001), Bae/Kang/Kim (2002), Capron/Pistre (2002), Fuller/Netter/ Stegemoller (2002), Graham/Lemon/Wolf (2002), Hayward (2002), Seth/Song/Pettit (2002), Wright et al. (2002), Fee/Thomas (2003), (Moeller et al. 2004, 2005), and Yook (2003). One finding regarding the valuation effects of M&A transactions is nearly global: Acquisition targets in almost all cases earn significantly positive abnormal returns [cf. (Jensen and Ruback 1983), (Bradley et al. 1988), etc.]. Contrarily, findings concerning the impact on acquiring firms' stock are highly diverse. Many studies show acquirers to experience insignificant or even negative abnormal returns [see the overview by (Bruner 2002) as well as recent evidence by (Capron and Pistre 2002), Fee/Thomas (2003), (Moeller et al. 2004, 2005) and others].[559] The smallest common denominator of such research is that bidder returns vary as a result of heterogeneous settings, objectives, and transaction structures.

[559] Several studies also analyze the combined wealth effect of mergers and acquisitions on buyer and target companies [cf. the Bruner (2001) review, among others].

Evidence on Value-Impact of Explanatory Variables

Table 54: Industry-level Explanatory Variables in Alliance & JV Event Studies (Industry Affiliation/Characteristics)

Charac-teristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Industry Affiliation	A	(Chan et al. 1997) (Anand and Khanna 2000a) (Kale et al. 2002)	3-digit SIC codes / Business Week 2- and 3-digit SIC codes 3-digit SIC codes	Sign.	n.s. n.s. n.s.
	JV IJV	Mohandram/Nanda (1996) (Chung et al. 1993)	Industry dummies Manufacturing, Transportation/ Telecommunications/Energy, Service, Oil/Gas/Mining		n.s. n.s.
Technolo-gical Basis	A	(Wu and Wei 1998) (Brooke and Oliver 2004) (Hanvanich et al. 2005) (Häussler 2006)	Medium-/High-Tech Industries High-Tech Industries High-Tech Firms High-Tech Firms (Biotech, Internet, IT, Software, Telecom) Neuer Markt Firm	+	n.s. n.s. – + +
Industry Competition	IJV	(Merchant and Schendel 2000)[560] (Merchant 2002)	Low Competition (Content Analysis of Value Line reports) Competitive efficiency (high industry rivalry dummy)	+	– +
Information Complexity	IJV	Madhavan/Prescott (1995)	Information processing load – No. of analyst reports per firm – No. of customer/supplier industries	–	+ – / +
(Focal) Firm Business Model	A	(Park et al. 2004) (Chiou and White 2005) (Park and Mezias 2005)	e-Commerce business model (B2C versus portals/B2B) Investment Banking Activities Insurance/Investment Products Activities e-Commerce business model (B2C versus portals/B2B)	Sign.	n.s. + – n.s.
	JV	(Koh and Venkatraman 1991)	Manufacturing versus non-manufacturing firms		n.s.

Source: Own Compilation

560 (Merchant 1995) documents a similar effect, although the positive value-impact of greater competition is not statistically significant.

Table 55: Industry-level Explanatory Variables in Alliance & JV Event Studies (Business Relatedness)

Charac-teristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Partner Relatedness	A	(Chan et al. 1997)	Within 3-digit SIC code		+
		(Wu and Wei 1998)	Inter-Industry R&D		–*?
		(Bayona et al. 2002a)	Competitor (vs. non-competitor) alliances		+
		(Karamanos 2002)	Same industry sector		n.s.
		(Vidal Suarez and García-Canal 2003)	Direct competitors: Same 3-digit SIC code		+ n.s.
		(Häussler 2006)	Horizontal vs. vertical vs. other (unspecified)		+
		(Wang and Wu 2004)	Intra-Industry versus Inter-Industry-Alliances		n.s.
		(García-Canal and Sánchez-Lorda Un-dated)	Horizontal versus Vertical Relatedness Direct competitors: Same 4-digit SIC code		–
	JV	(Koh and Venkatraman 1991)	Same products/markets, production technology, R&D	+	+
		Balakrishna/Koza (1993)	Dissimilarity: normalized difference in 3-digit SIC codes (reverse)		+*
		(Park and Kim 1997)	Monopoly power: same 3-digit SIC codes		+
		Houston/Johnson (2000)	Direct competition: Same 4-digit SIC code		–
		Reuer/Koza (2000)	Horizontal vs. vertical joint ventures / downstream vs. upstream		+
	IJV	(Merchant and Schendel 2000)	Unrelated partners: Different 3-digit SIC codes (reverse)		+*
		Gulati/Wang (2001)	Subjective measure of relatedness (5-point Lickert scale)		n.s.
		(Merchant 2002)	Business relatedness: Same 2-digit SIC code Subjective measure of relatedness (5-point Lickert scale)		n.s. +
Relatedness to Collaborative Activity	A JV	Bayona/Corredo/Santamaría (2002a)	Same Activity as Focal Firm	+	+
		Ravichandra/Sa-Aadu (1988)	Geographical proximity to JV site (informational advantage) Technological expertise in area of joint venturing		+ + ***
		Koh/Ventakaram (1991)	Product relatedness (= same 4-digit SIC code) Market/Geographical relatedness		n.s. (+**) +
		(Mohanram and Nanda 1996)	Same 4-digit SIC code (also same as partner firm) Same 4-digit SIC code (different from partner firm)		– +

Table 55 (Continued)

Charac-teristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Relatedness to Collaborative Activity	A JV	(Park and Kim 1997)	Relatedness: Overlap in Product/Market Scope	+	+
		Gulati/Wang (2001)	Asymmetry: only one partner in same 2-digit SIC code		–*
		Schut/Van Fredriks-lust (2002)	Normalized difference in 3-digit SIC codes (reverse)		–*
		Hanvanich et al. (2005)	Task Relatedness (same 2-digit SIC)		n.s.****
		(Merchant and Schendel 2000)	Subjective measure of relatedness (5-point Lickert scale)		+

* reverse-coded, i.e.
** If partner with larger sales in business related to JV
*** Effect marginally significant
**** Significantly positive interaction effect with high-technology industry dummy

Source: Own Compilation

Table 56: Industry-level Explanatory Variables in M&A Event Studies (Business Relatedness)

Effect of Relatedness in Mergers & Acquisitions (M&A)
Relatedness of acquiring and target firms has implications for their synergetic value creation and for competitive effects, in particular issues of monopoly and market power. First, most empirical studies have documented significantly higher abnormal (bidder) returns to horizontal as opposed to unrelated acquisitions [cf. Rumelt (1974), Singh/Montgomery (1987), Balakrishna/Koza (1993), Comment/Jarrell (1995), Maquieira et al. (1998), DeLong (2001), among others]. More specifically, Shelton (1988) shows acquisitions building on similar technologies to serve different (related-supplementary acquisition) or similar (identical acquisition) customers yield significantly positive abnormal returns, whereas those joining different product offerings to address similar (related-complementary) or different (unrelated) target groups do not. Walker (2000) confirms negative abnormal returns for diversifying acquisitions, especially if these are somewhat similar to existing acquirer operations (overlap). Contrarily, Graham/Lemon/Wolf (2002) show abnormal returns to diversifying acquisition to be positive in spite of lower combined entity values relative to comparable stand-alone firms [using the Berger/Ofek (1995) methodology]. This discrepancy may, as they argue, be due to endogeneity of the diversifying acquisition itself. In particular, target firms being significantly undervalued ex ante account for much if not all of the discount later experienced by the merged entity. Overall, however, recent evidence favors related acquisitions. A second line of research has studied the value impact on industry rivals, suppliers, and customers of merging entities. In this context, positive (negative) abnormal returns to rivals may indicate danger of collusion (improved efficiency) due to the larger size of the merged firm. Empirical evidence clearly supports the collusion argument, documenting a significantly positive return to rivals upon the announcement of proposed acquisitions [cf. Eckbo (1983) and Fee/Thomas (2003)]. Similarly, customers [cf. Mullin/Mullin/Mullin (1995)] and suppliers [cf. Fee/Thomas (2003)] stand to loose (i.e. experience negative abnormal returns) due to increased market power. However, some authors have failed to document such adverse effects [e.g. Fee/Thomas (2003) for the case of customers]. Also, findings in support of bargaining power may be specific for certain time periods and industries.

Source: Own Compilation

Table 57: Institutional-level Explanatory Variables in Alliance & JV Event Studies (International Context)

Characteristic	Type	Authors (Year)	Variables	Predicted Sign	Effect found
International scope[561]	A	(Kim and Park 2002)	Partner from country other than home country	+	$+^{**}$
		(Wang and Wu 2004)	Domestic Alliances (and global alliances with domestic partner)		$+^{*}$
		(García-Canal and Sánchez-Lorda Undated)	Global/Multi-Country Scope		+
	JV	(He et al. 1994)	Joint venture with international partner		n.s.
		(Park and Kim 1997)	Joint venture with international partner		n.s.
		(Hanvanich et al. 2005)	International partner		–
	IJV	(Hanvanich et al. 2003)	JVs in home country (irrespective of partner origin)		$+^{*}$
Partner origin	A	(Sleuwaegen et al. 2003)	European Partner	Sign.	+
			U.S. Partner		n.s.
			Japanese or Non-triad Partner		–
		(Vidal Suarez and García-Canal 2003)	Partners from EU versus other OECD and Non-OECD countries		n.s.
		(Chiou and White 2005)	International (i.e., Non-Japanese) partner		n.s.
		(Häussler 2006)	Foreign partner		n.s
	IJV	(Lee and Wyatt 1990)	Partners from Less developed countries		+
		(Chung et al. 1993)	Partners from less developed country		n.s.
		(Irwanto et al. 1999)	Less developed countries		+
		(Chen et al. 2000)	Partners from developed country		n.s. (+)
		(Gupta and Misra 2000)	Partners from developed country		–
		(Hanvanich et al. 2003)	Traditional foreign JVs (vs. cross-/tri-national JVs)		–
Host Country	IJV	(Merchant and Schendel 2000)	Political risk of host country	Sign.	n.s.
			Developed destination country		+
		(Ueng et al. 2000)	Political risk of host country		n.s.
		(Merchant 2002)	JVs in Continental Europe (vs. UK/US)		+
		(Jones and Danbolt 2004)	JVs in Asia/Pacific (vs. UK/US)		–
		(García-Canal and Sánchez-Lorda Undated)	Political Constraints		n.s.
Home Country		(Kim and Park 2002)	Japan / South Korea	Sign.	–

* reverse coded
** Effect only significant for day zero (cumulative multi-day abnormal returns insignificant)

561 For mergers and acquisitions, evidence regarding geographical diversification is also rather diverse. While Walker (2000) finds significantly positive abnormal returns to firm expanding their geographical scope, DeLong (2001) exhibits an inverse relationship.

Table 57 (Continued)

Charac-teristic	Type	Authors (Year)	Variables	Predicted Sign	Effect found
Cultural Distance	A	(Kim and Park 2002)	Negative, normalized cultural distance measure	+	–**
		(Vidal Suarez and García-Canal 2003)	Cultural distance [Kogut/Singh (1988)]		n.s.
		(García-Canal and Sánchez-Lorda Undated)	Cultural distance		n.s.
	JV	(Schut and Van Fredrikslust 2002)	Normalized difference in national individualism scores		+
		(Hanvanich et al. 2005)	National Culture Differences [Kogut/Singh (1988)] to host country		+****
	IJV	(Merchant and Schendel 2000)	Negative cumulative deviation in variance-adjusted culture scores [Kogut/Singh (1988)]		n.s.
		(Merchant 2002)	Absolute difference in individualism scores (Hofstede)		n.s. (–)
		(Hanvanich et al. 2003)	No (partner) cultural difference		+*
			Double-layered acculturation (partner & location differences)		–
International Experience		(Meschi et al. Undated)	Managerial experience (No. of prior JVs in China)	–	+***
		(Meschi 2004)	General international experience (% of sales)		+***
			European experience (% of sales)		–***
			Asian experience (% of sales)		???

* reverse coded
** Effect only significant for cumulative multi-day abnormal returns (day zero insignificant)
*** Effect only significant for individual days within the observation window (no cumulative abnormal returns presented)
**** Significantly negative interaction effect with high-technology industry dummy

Table 58: Institutional Explanatory Variables in Alliance & JV Event Studies (Market Context)

Characteristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Investment Environment	A	(Park and Mezias 2005)	Environmental munificence (after March 2000) Equity Market Index	–	+*/** n.s.
	JV	(Schut and Van Fredrikslust 2002)	Risk-free return: 10-year government bond		–
Value of Investment Opportunities	A	(Brooke and Oliver 2004)	Low Growth Firms [~(MV-BV)/BV]		+*
	JV IJV	(Schut and Van Fredrikslust 2002) (Chen et al. 2000) (Vidal Suarez and García-Canal 2003)	Current market-to-book ratio relative to 5-year average Investment Opportunity: pseudo q (absolute, relative, change) Tobin's q	+	n.s. + +
Other institutional Characteristics	A	(Park and Mezias 2005)	No. of prior alliances in the industry		n.s.***

* reverse-coded
** Low environmental munificence (after March 2000) also interacts positively with marketing alliances and 'brick and mortar' partner firms.
*** sign. + if not simultaneously controlling for environmental munificence

Table 59: Institutional Explanatory Variables in M&A Event Studies (Market Context)

Capital Market Effect in Mergers & Acquisitions (M&A)

Evidence for mergers and acquisitions is less positive showing insignificant [cf. Moeller/Stegemann/Stultz (2003a, b)] or negative [cf. Rau/Vermaelen (1998)] relations between q or MB and abnormal bidder returns. Thus, higher valuation levels may lead to less profitable mergers and acquisitions. Generally, high valuation periods are associated with higher M&A volume relative to market capitalization [cf. Jovanovic/Rousseau (2001)] and more stock used as acquisition currency [cf. Dong et al. (2003)]. Together with the discount for stock-financed acquisitions discussed above, this supports the hypothesis of overvalued firms buying less overvalued ones [cf. Rhodes-Kropf/Robinson/Vishwanathan (2003)], which in return is not value-enhancing. Contrarily, Bouwman/Fuller/Nain

(2003) find positive abnormal announcement returns in high valuation periods.[562] The negative effect of high stock values may thus be limited to specific firms or transaction structures. Clearly, a sharp contrast exists between acquisitions and collaborative agreements (i.e. joint ventures and contractual alliances).

Market Activity Effects in Mergers & Acquisitions (M&A)

Furthermore, the market for corporate control has a substantive influence on the valuation effect of mergers and acquisitions. First, the efficiency of the market for takeover transactions as a whole has an adverse effect on the value appropriated by acquiring firms. The danger of alternative bids may reduce the realizable gains for bidding forms, if M&A activity is common [cf. (Moeller et al. 2004, 2005), among others]. Similarly, Seth/Song/Pettit (2002) find value creation through hubris-related acquisitions to be higher in countries with bank- or group-oriented governance systems, where market-based control activity is less common.

Second, the presence of multiple bidders is generally associated with lower abnormal returns to succeeding bidders [cf. Hayward (2002), (Moeller et al. 2004, 2005)]. While the rationale behind this evidence is equivalent to the one above, the overall impact of competing bidders on the joint value created by the transaction (i.e. accruing to acquiring and target shareholders) may well be positive, as documented by Shelton (1988). In this context, rival bidders may be a sign of quality regarding the acquisition target or increase the likelihood of the value-maximizing bidder acquiring it [e.g., (Bradley et al. 1988)]. In support of this optimal asset owner hypothesis, Seth/Song/Pettit (2002) show a significantly higher overall (i.e. bidder and target) value increase for competed bids.[563]

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[562] However, Bouwman/Fuller/Nain (2003) themselves find long-term stock returns to be negative for acquisitions made during periods of high market valuations.

[563] Interestingly, bidder returns are not necessarily diminished by multiple bidder activity. Seth/Song/Pettit (2002) differentiate several acquisition motives and find multiple bidders having a negative impact on bidder returns only for managerialist or hubris-related transaction. Bidders acquiring firms for synergistic reasons do not suffer from rival bidders.

Table 60: Firm-level Explanatory Variables in Alliance & JV Event Studies (Firm Size)

Charac-teristic	**Type**	**Authors (Year)**	**Variables**	**Pre-dicted Sign**	**Effect found**
Firm Size	A	(Wu and Wei 1998)	Log of market value		–
		(Anand and Khanna 2000)	Assets No of Employees		n.s. n.s.
		Park/Martin (2001)	Sales		n.s.
		(Kale et al. 2002)	Total Assets		n.s.
		(Karamanos 2002)	Market Value of Equity		n.s.
		Kim/Park (2002)			
		Campart/Pfizter (2003)	Log of Revenues		–
		(Arend 2004)	Log Sales		–**
		(Jones and Danbolt 2004)	Log of market capitalization (quarterly average)		–
		(Park et al. 2004)			n.s.
		(Burton 2005)	Market Value		–
		(Park and Mezias 2005)	Log of market capitalization (quarterly average)		–
		(Häussler 2006)	Log of Market Capitalization (day t-3)	–	–
		(Chang and Kuo undated)	Market Value of Assets		n.s.
	JV	(Cordeiro 1993)	Logarithm of the Number of Employees		–
		(Mohanram and Nanda 1996)	Smaller firms (reverse)		+*
		Gulati/Wang (2001)	Total sales of both partners (logged)		n.s.
	IJV	(Chen et al. 2000)	Logarithm of market value of assets		n.s.
		Gupta/Misra (2000)	Total assets		+
		(Merchant and Schendel 2000)	Logarithm of market capitalization		+
		(Ueng et al. 2000)	Natural logarithm of market value		n.s.
		(Merchant 2002)	Natural logarithm of U.S. partner market capitalization		–
Firm Age	A	(Park et al. 2004)	Firm age (log of days since IPO)		+
		(Häussler 2006)	Firm age (log of days since IPO)	–	+
		(Park and Mezias 2005)	Firm age (log of days since IPO)		+

* reverse-coded

** Observed Effect: Smaller reduction in stock volatility (price volatility 90-day before and after transaction announcement)

Source: Own Compilation

Table 60 (Continued)

Charac-teristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Relative Size	A	(Chan et al. 1997)	Larger market value of common stock (day t-21)	–	–
		(Das et al. 1998)	Larger total assets, net sales, and total No. of employees		–
		Neil/Pfeiffer/Young-Ybarra (2001)	Larger size [Not specified]		n.s.
		Kim/Park (2002)			
		Campart/Pfizter (2003)	Relative market value of equity		n.s.
		(Chiou and White 2005)	Larger Partner		–
		(Häussler 2006)	Smaller Size (Assets)		+*
			Small Firm (below median mktcap) collaborating with large firm		+*
	JV	(McConnell and Nantell 1985)	Relative market value of common equity		
			- abnormal returns (%) as dependent variable		–
			- value generated ($) as dependent variable		+
		Koh/Ventakaram (1991)	Relative market value of common equity		–
		Mohandram/Nanda (1996)	Ratio of firms' market values of equity		n.s.*/**
		Kim/Park (2002)	Relative market value of common equity		–
		Schut/Van Fredrikslust (2002)	No. of partner employees / No. of own employees		+*
	IJV	(Crutchley et al. 1991)	Larger market value of common stock		
			- for Japanese firms		+
		(Merchant and Schendel 2000)	- for U.S. firms		n.s.
			Negative logarithm of difference in No. of employees		n.s.

* reverse-coded

** Effect is significantly positive for very small firms, who profit from asymmetric joint ventures with larger partners

Source: Own Compilation

Table 61: Firm-Level Explanatory Variables in M&A Event Studies (Firm Size)

Size Effects in Mergers & Acquisitions (M&A)
For mergers and acquisitions, the size of the acquiring entity is generally negatively related to the experienced value impact [cf. Asquith/Bruner/Mullins (1983), among others]. (Moeller et al. 2004, 2005) even show bidder size differences to be the dominant force behind value creation and destruction in M&A activity. Eckbo/Thorburn (2000) identify size differences as the only viable explanation for positive abnormal returns earned by (smaller) domestic/Canadian as opposed to negative abnormal returns for (larger) foreign/U.S. acquirers.
Evidence on the relative size of acquisition targets may be somewhat incomparable to alliances and joint ventures, since they are generally smaller than the acquiring firm. At large, the size of the acquisition target positively influences the acquirer's abnormal returns [cf. Walker (2000), (Kohers and Kohers 2000), (Moeller et al. 2004, 2005)]. Overall, larger acquisition targets may simply provide access to more valuable resources and possess better established market positions. However, Fuller/Netter/Stegemoeller (2002) provide an interesting nuance by showing an significant inverse relationship for acquisitions of privately held firms and subsidiaries. Such firms may not provide the economies of scale and market power advantages associated with larger acquisitions.

Table 62: Firm-Level Explanatory Variables in Alliance & JV Event Studies (Firm Resources)

Charac-teristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Partner Resources	A	(Stuart et al. 1999)* (Park and Martin 2001) (Karamanos 2002) (Yao and Ge 2002)	Cumulative funding provided by alliance partners Interaction of Resource Value, Rareness, and Inimitability Partner Network Centrality (Clique/Degree measures) Technological capital: No. of patents / No. of citations Social capital: No. of network ties / Network efficiency	+	n.s. + + – / + n.s. / +
Partner Reputation	A	(Stuart et al. 1999)* Houston (2003)	Commercial prominence: No. of organizational ties Technological prominence: No. of patent citations Bank size: total deposits Quality of bank loans: loan loss provisions / total loans Bank capital structure: stockholder equity / total assets	+	+ n.s. + – +
Other partner charac-teristics	A	(Park et al. 2004) (Park and Mezias 2005)	Online-online alliances (vs. partners with offline sales) Brick-and-Mortar vs. e-commerce partner business model	+	n.s. n.s.
	IJV	(Chung et al. 1993) (Chen et al. 2000) (Merchant 2002)	Publicly listed partner Foreign firms (versus foreign governments) Type of partner (non-state-owned enterprise)		– n.s. +
Focal Firm Resources & Charac-teristics	A	(Karamanos 2002)	Focal Firm Network Centrality (Clique/Degree measures)	+	-**

* Study refers to the influence of alliance partner characteristics (also: No. of alliances) on pre-money IPO valuations.

[** Total percentage gains and bidder returns as dependent variables, respectively]

** Effect only significant for pure R&D (i.e. learning) alliances

Table 63: Firm-Level Explanatory Variables in Alliance & JV Event Studies (Transaction Experience)

Characteristic	Type	Authors (Year)	Variables	Predicted Sign	Effect found
Transaction Experience & Capability	A	(Anand and Khanna 2000)	Alliance experience: No. of prior joint ventures and licensing agreements (since 1990)	+	+
		Kale/Dyer/Singh (2001, 2002)	Alliance Experience: No. of prior alliances		+
			Dedicated Alliance Funct.		+
		Park/Martin (2001)	Alliance experience		n.s.
		(Karamanos 2002)	No. of prior alliances		n.s.
		Kim/Park (2002)	No. of prior alliances		n.s.
		Nicholson/Danzon/ McCullough (2002)	First alliance deal signed (dummy variable)		+
		(Janney and Folta 2003)	Time elapsed since last research/commercial alliance		+ / n.s
		(Park et al. 2004)	No. of previous alliances (since founding)		n.s.
		(Park and Mezias 2005)	No. of previous alliances (since founding)		n.s.
		(García-Canal and Sánchez-Lorda Undated)	Alliance experience		n.s.
	JV	Gulati/Wang (2001)*	Tie embeddedness: direct + indirect ties + interaction		+
	IJV	(Gupta and Misra 2000)	High experience (> 3rd for firm)		+
			Prior IJV in same country or with partner from country		+
		(Merchant and Schendel 2000)	No. of Joint Ventures since 1986		n.s.
		(Merchant 2002) (Merchant 2003)	No. of previous IJV		n.s.
		(Meschi 2004)+	No of prior JVs in China		+
			International Business Experience (% of Sales)		+
			Asian Business Experience (% of Sales)		n.s.
Prior Partner Relations	A	(Park and Martin 2001)	No. of prior alliances between partners	+	n.s.
		(Bayona et al. 2002a)	Existence of prior Relationship between partners		+
		(Vidal Suarez and García-Canal 2003)	Previous collaboration between partners		n.s.
		(Chiou and White 2005)	Intra-Keiretsu Alliances		–
	JV	(Cordeiro 1993)	Number of Board Interlocks (per Director?)		+
		(Park and Kim 1997)	Prior relationship (within last 5 years)		–
		(Gulati and Wang 2001)			+

* Study refers to the influence of alliance partner characteristics (also: No. of alliances) on pre-money IPO valuations.

** significant negative coefficient of squared term [similar findings also for other interlocks such as board representation]. Independent variable is the overall value creation through a given transaction, irrespective of its attribution to the parties involved.

*** latter effect significant only for private/subsidiary acquisitions

Table 64: Firm-Level Explanatory Variables in Alliance & JV Event Studies (Firm Performance and Governance)

Charac-teristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Firm Performance	A	(Das et al. 1998)	Internal rate of return (= net in-come / book value)	–	–
		(Kim and Park 2002)	Return on Assets		n.s.
			Relative profitability (normalized partner ranking)		–
		(Campart and Pfister 2003)	Log profit/turnover		+
		(Brooke and Oliver 2004)	High versus Low Free-Cash-Flow Firms		n.s.
		(Chang and Kuo undated)	Below median Return-on-Investment		+*
			Dividend Yield (Growth Oppor-tunities)		n.s.
	JV	(Mohanram and Nanda 1996)	Return-on-Equity, Return-on-Assets		n.s.
			Free Cash Flows, Sales Growth		–
	IJV	(Gulati and Wang 2001)	Return on Assets (difference be-tween firms)		n.s.
		(Chen et al. 2000)	Cash flow (relative to book value of assets)		n.s.
		(Gupta and Misra 2000)	Profit margin (on sales)		n.s.
		(Ueng et al. 2000)	5-year compounded growth of FCF/dividend payout ratio		n.s.
Leverage	JV	(Mohanram and Nanda 1996)	Leverage	+	–
	IJV	(Gulati and Wang 2001)	Solvency: long-term debt / cur-rent assets		n.s.
		(Chen et al. 2000)	Debt ratio		n.s.
	A	(Chang and Kuo undated)	Debt Ratio		n.s.
Governance	A	(Chang and Kuo undated)	Managerial ownership	+	n.s.
	JV	(Cordeiro 1993)	Insider Ownership (officers & di-rectors; log % +1)		+
			Institutional Ownership		n.s.
			Share of Outside Directors		n.s.
			Long-Term Management Com-pensation Plan		+
		(Park and Kim 1997)	Institutional ownership: % of common voting stock		+
	IJV	(Chen et al. 2000)	Insider ownership: % of common voting stock		+
			Managerial ownership		n.s.

* reverse coded

Table 65: Firm-Level Explanatory Variables in M&A Event Studies (Firm Performance and Governance)

Slack Resource Effects in Mergers & Acquisitions (M&A)
Bae/Kang/Kim (2002) among others exhibit a negative effect of FCF on the value impact of M&A transactions. However, Yook (2003) shows a positive effect of FCF in cash-financed acquisitions. In particular, acquirers holding excess cash ex ante experience significantly lower abnormal returns [cf. earlier studies by Servaes (1991), Lang/Stultz/Walkling (1991), and Harford (1999)]. This highlights the danger of management using cash assets for non-value-creating acquisitions rather than returning it to the companies shareholders. Consequently, bidder slack resources may lead to lower abnormal returns unless they are used to acquire targets lacking such resources, such as suggested by the findings of Bruner (1988). He specifically shows abnormal bidder returns to be non-negative if the debt-equity ratio of acquiring firms increases upon completion of the transaction. Similarly, Moeller/Schlingemann/Stultz (2004, 2005) show (ex ante) leverage as increasing the abnormal returns experienced by acquiring (public) firms. Moreover, Yook (2003) find cash-financed acquisitions leading to a downgrade in debt ratings as earning significantly higher abnormal returns.

Control Effects in Mergers & Acquisitions (M&A)
Insider ownership is associated with higher abnormal returns in high-technology acquisitions, whereas (outsider) institutional ownership leads to lower AR [cf. Kohers/Kohers (2000), who also show that the marginal effect of increased insider ownership is negative, but insignificantly so]. Other M&A studies [e.g. You/Caves/Smith/Henry (1986)] provide supporting evidence, since they show low equity stakes held by acquiring firm management to be related to low/negative abnormal returns. The mixed evidence regarding institutional ownership may be due to the specific characteristics of high-technology acquisitions [studied by Kohers/Kohers (2000)], which may be difficult to evaluate by outsiders. Formalized influence by institutional investors may in those cases lead to the rejection of value-creating transactions or be associated with significant coordination costs.

Table 66: Transaction-Level Explanatory Variables in Alliance & JV Event Studies (Transaction Function/Objective)

Charac-teristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Alliance Function (Technology/ R&D)	A	(Chan et al. 1997)	Transfer or pooling of technological knowledge	+	+
		(Das et al. 1998)	Technology versus marketing alliances		+
		(Karamanos 2002)	Technology versus marketing/distribution alliances		(+)
		(Campart and Pfister 2003)	Technology versus Non-Technology Alliances		+
		(Sleuwaegen et al. 2003)	Production/Marketing alliances (n.s. AR for technology)		+*
		(Brooke and Oliver 2004)	Technology vs. Marketing vs. R&D alliances		n.s.
		(Park et al. 2004)	Marketing alliances (versus technology)		+*
		(Park and Mezias 2005)	Marketing alliances (versus technology)		+*
		(Häussler 2006)	Marketing versus R&D versus Licensing		n.s.*
		(García-Canal and Sánchez-Lorda Undated)	R&D versus Manufacturing versus Marketing Alliances		n.s.
		(Chang and Kuo undated)	Technology (lic/R&D/Tech. Transfer) vs. non-technology alliances		n.s.
	JV	(Koh and Venkatraman 1991)	Technology exchanges (vs. licensing, marketing, supply)		+
		(Schut and Van Fredrikslust 2002)	Technology development (relative to marketing)		+
			Operational efficiency (relative to marketing)		+
	IJV	(Merchant and Schendel 2000)	R&D JV (versus marketing/manufacturing)		+
		(Merchant 2002)	Manufacturing JVs (as opposed to n.s. R&D/Marketing)		–*
Scope of Cooperation	A	(Kim and Park 2002)	Industry expert classification: narrow to broad	+	+
		(Vidal Suarez and García-Canal 2003)	Regional (as opposed to 2-country or unspecified) scope		+
		(Arend 2004)	Collaboration in Core Business		–**
			~(Merchant and Schendel 2000)		
		(Chiou and White 2005)	Multi-Business Alliances		+
			Comprehensive Alliances		n.s.
Resource Creation versus Transfer	A	(Chan et al. 1997)	R&D versus other alliances	+	n.s.
		(Neill et al. 2001)	R&D alliances		+
		(Karamanos 2002)	Commercialization versus R&D		+*
		(Arend 2004)	Standard Setting Alliance		+**
	JV	(Woolridge and Snow 1990)	Sharing assets/resources vs. R&D/asset construction		+*

Table 66 (Continued)

Charac-teristic	**Type**	**Authors (Year)**	**Variables**	**Pre-dicted Sign**	**Effect found**
Direction of Resource Transfer (Outbound)	A	(Park and Kim 1997)	One-sided technology transfer (technology provider)	+	–
		(Campart and Pfister 2003)	Technology-Selling versus Technology-Buying Partner		+
		(Wang and Wu 2004)	Buyer versus Supplier in Vertical Alliances		+*
		(Burton 2005)	Supplier in Vertical JVs (n.s. AR for buyer)		+
	JV	(Johnson and Houston 2000)	Supplier in Vertical JVs (n.s. AR for buyer)		+

* reverse coded
( ) result subject to differences across event windows or estimation methods
** Observed Effect: Reduction in stock volatility (change in implied volatility; log of ratios)

Table 67: Transaction-Level Explanatory Variables in Alliance & JV Event Studies (Transaction Structure)

Charac-teristic	**Type**	**Authors (Year)**	**Variables**	**Pre-dicted Sign**	**Effect found**
Contractual Alliances versus JVs	A/JV	(McConnell and Nantell 1985)			
		(Wu and Wei 1998)	RJV (or Co-Development) vs. contractual R&D project	+	n.s.
		(Anand and Khanna 2000)	Joint Ventures versus licensing agreements ($, %)	n.s.	+/–
		(Koh and Venkatraman 1991)	Joint Ventures (and technology exchange agreements) versus licensing, marketing, and supply agreements	+	+
			JV versus contractual alliances	n.s.	n.s.
		(Campart and Pfister 2003)	JV versus contractual alliances	n.s.	+**
		(Arend 2004)	JV versus contractual alliances (all transactions)	n.s.	n.s.
		(Piachaud and Muresan 2004)	JV versus contractual alliances (technology-motivated transactions)	+	+
		(Burton 2005)	JV versus contractual alliances	n.s.	–
Equity versus Contractual Alliances	A	(Kale et al. 2002)	Equity versus non-equity alliances (unspecified)	n.s.	+
		(Kim and Park 2002)	Equity versus non-equity alliances (investor)	+	+
		(Wang and Wu 2004)	Equity versus non-equity alliances	n.s.	n.s.
		(Chiou and White 2005)	Equity versus non-equity alliances	n.s.	n.s.
		(Chang and Kuo undated)	Equity versus non-equity alliances	n.s.	+

Table 67 (Continued)

Charac-teristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Joint Venture Ownership	JV IJV	(Park and Kim 1997) (Schut and Van Fredrikslust 2002) (Merchant and Schendel 2000) (Merchant 2002)	Majority owner in JV Majority owner in JV Ownership share (in %) Evenly shared control (irrespective of ownership) Ownership share of U.S. partner (%)	+	+/– * + + – n.s.
No. of Partners[564]	A	(García-Canal and Sánchez-Lorda Undated)	No. of partnering firms (different 4-digit SIC codes) No. of partnering firms (same 4-digit SIC code)	–	– +
Focal Firm Transacton Cost Indicators	JV IJV	(Mohanram and Nanda 1996) (Ueng et al. 2000)	Asset-to-Sales-Ratio/R&D intensity 5-year compounded growth of R&D/marketing expenditures	–	n.s./ n.s. +/+

* For smaller and larger JV parent, respectively
** Reduced stock volatility (implied volatility; difference from recent average)

Table 68: Transaction-Level in Explanatory Variables M&A Event Studies

Strategic Objectives of Mergers & Acquisitions (M&A)

Finally, the strategic context of mergers and acquisitions also represents an important variable in explaining their value creation. It has been studied in great variety and includes several different aspects: First, the positive abnormal (bidder) returns for high-technology acquisitions documented by Kohers/Kohers (2000) complement the above evidence for alliances and joint ventures and suggest that technology access may be value-enhancing regardless of the type of combination. Second and more generally, the market may differ in its reaction to cost saving and revenue enhancement motives for acquisitions. For instance, Houston/James/Ryngaert (2001), studying bank mergers, show both positively related to value creation, but the revenue-increasing benefits appear to be more

564 Similarly, several transaction- and agency-cost-related factors have been considered: On the one hand, (García-Canal and Sánchez-Lorda Undated) observe the number of partnering firms of (unrelated) collaborating firms to significantly reduce wealth gains. On the other hand, evidence does not support an asset-intensity argument for collaborative AR [(Mohanram and Nanda 1996), (Ueng et al. 2000)]. Neither aspect has thus received the further empirical support.

strongly discounted than cost savings. Similarly, Mueller (1985), Ravenscraft/Scherer (1987), and Eckbo (1992) do not find significantly positive abnormal returns for positioning M&A. Third, some prior research has focused on acquisition programs announced including (but not limited to) those with a diversification motive. Asquith/Bruner/Mullins (1983) and Gregory (1997) are among those to observe significantly positive abnormal returns to acquisitions being part of strategic acquisition programs as opposed to those that are not.[565]

Structural Issues in Mergers & Acquisitions (M&A)

Third, for mergers and acquisitions, the structural aspects of a transaction have little implications for post-acquisition conduct (e.g. integration), but reflect the economic rationale behind those transactions. Specifically, the distinction of tender offers and mergers is relevant for value creation, since it refers to the degree of consent between acquirer and target management. (Often hostile) tender offers are generally associated with larger abnormal returns to bidding firms than (friendly) negotiated mergers [cf. Jarrell/Poulsen (1989), Lang/Stultz/Walkling (1989), Rau/Vermaelen (1998) etc.]. This highlights the role of acquisitions as a mechanism for replacing inefficient management. While mergers are agreed to for reaping strategic or even personal benefits, hostile tender offers serve as a disciplinary governance mechanism.

[565] In this context, Balakrishnan (1988) argues that the synergies derived from an acquisition program may well be anticipated by the stock market, leading to insignificant or even negative announcement returns for an individual acquisition. Focusing on a specific takeover, he finds different news events preceding the actual transactions to earn significantly positive returns, whereas abnormal returns to the acquisition announcement itself are insignificant.

Table 69: Transaction-Level Explanatory Variables in Alliance & JV Event Studies (Financial Transaction Characteristics)

Charac-teristic	Type	Authors (Year)	Variables	Pre-dicted Sign	Effect found
Investment Size	A JV IJV	(Burton 2005) (Jones and Danbolt 2004) (Chen et al. 1991) (Chen et al. 2000)	Investment-based Collaboration (i.e., requiring new CapEx) Project Size (relative to focal firm MV) Investment volume Investment required [relative to total assets]	–	– + – n.s.
Direction of Financial Flows (Inbound)	A JV	(Park and Martin 2001) (Campart and Pfister 2003) (Wang and Wu 2004) (Häussler 2006) (Jones and Danbolt 2004)	Net equity inflow Net financial inflow Equity investment in partner (out-flow) Equity investment in partner (out-flow) Share of Investments by Focal Firm	+	+ + –* –* –*

* Interaction terms of these variables with relative size of target are significant and in same direction as main effect

** For acquisitions paid for in cash and in stock, respectively

Table 70: Transaction-Level Explanatory Variables in Alliance & JV Event Studies (Financial Transaction Characteristics)

Method of Payment Effect in Mergers & Acquisitions (M&A)
Using stock as acquisition currency generally leads to value destruction (i.e. significantly negative abnormal returns), as shown by various authors including Asquith/Bruner/Mullins (1987) and Mueller/Schlingemann/Stultz (2003a, b). Conversely, transactions paid for in cash earn positive (or non-negative) returns [cf. Walker (2000), Calvet/Lefoll (1987)]. Both findings conform to the adverse selection problem associated with stock issues [cf. Myers/Majuf (1984)], i.e. stock being used, when firms are overvalued, and cash otherwise. While this relation is well documented, it is not universal. Mueller/Schlingemann/Stultz (2004, 2005) and others show it to be limited to the acquisition of publicly traded targets. Additionally, Kohers/Kohers (2000) cannot detect a negative impact of stock deals for high-technology acquisitions.

Summary and Discussion of Prior Event Study Evidence

Table 71: Summary of Prior Event-Study Research in Strategic Alliances and Joint Ventures

Theoretical School	Proposition	Key Concepts	Level of Analysis	Prior Research		Variable Clusters	Examples
				Extent	Consistency		
Industrial Economics & Corporate Strategy	1.1	Market Power	Environment / Transaction	■	(■)	Industry Concentration Relatedness (Horizontal)	(Chan et al. 1997) (Merchant and Schendel 2000)
	1.2	Spillover Internalization	Transaction	■	(■)	Transaction Type (R&D)	(Chan et al. 1997) (Merchant and Schendel 2000)
	1.3	Market Entry/Barriers to Entry	Transaction	■	(■)	Transaction Type (R&D, Marketing)	Koh/Venkatraman (1991) (Das et al. 1998)
	1.4	First Mover Advantage	Environment	(■)	□	Industry Type (High/low Technology)	Hanvanich et al (2005) Häussler (2006)
	1.5	Positioning Alliance / Competitive Advantage	Environment	□	□		None
Resource-based View	2.1	Technological Capital	Firm/ Transaction	■	(■)	Own/Partner Technology Base Transaction Type (R&D)	Park/Martin (2001) (Karamanos 2002) Yao/Ge (2002)
	2.2	Commercial Capital	Firm	■	(■)	Own/Partner/ Relative Size, Own Age, Partner Resources	(Anand and Khanna 2000) Kale/Dyer/Singh (2000) Park/Mezias (2005)
	2.3	Social Capital	Firm	(■)	(■)	Partner Social Capital Own Social Capital	(Karamanos 2002) Yao/Ge (2002)
	2.4	Alliance Experience	Firm	■	■	Own Alliance Experience	(Anand and Khanna 2000) Kale/Dyer/Singh (2000)
	2.5	Absorptive Capacity	Firm	□	□		None

Table 71 (Continued)

Theoretical School	Proposition	Key Concepts	Level of Analysis	Prior Research: Extent	Prior Research: Consistency	Variable Clusters	Examples
Transaction Cost Economics	3.1	Asset Specificity	Firm/ Transaction	■	(■)	Contractual collaboration vs. equity-based governance	McConnell/ Nantell (1985) (Park and Kim 1997)
	3.2	Environmental Uncertainty	Environment				(Anand and Khanna 2000) Piachaud/Muresan (2004)
	3.3	Transaction Scope	Transaction	(■)	□	Alliance Scope (limited) International Scope	Kim/Park (2002) Wang/Wu (2004)
	3.4	Transaction Cost Perception	Firm	(■)	(■)	Cultural Dissimilarity International Experience	Vidal S./Garcia C. (2003) (Hanvanich et al. 2003)
Game/ Agency Theory	4.1	Information Asymmetries (Management-Owner)	Firm	■	(■)	Own performance/leverage/ governance/ growth opportunities	Cordeiro (1993) (Chen et al. 2000) Campart/ Pfister (2003)
	4.2	Information Asymmetries (between Partners)	Firm/ Transaction	(■)	(■)	Knowledge relatedness	Koh/Venkatraman (1991) Bayona/Corr./Sant. (2002a)
	4.3	Contractual Safeguards	Transaction	□	□		None
	4.4	Inter-partner Trust	Transaction	■	(■)	Prior relations between partners	Gulati/Wang (2001) Chiou/White (2005)
	4.5	Patent Protection	Environment	□	□		None
Dynamic Theory	5.1	Environmental Change	Environment	(■)	(■)	Environmental munificence	Park/Mezias (2005) Schut/Van Fredriksl. (2002)
	5.2	Environmental Uncertainty		□	□		None

Table 71 (Continued)

Theoretical School	Proposition	Key Concepts	Level of Analysis	Prior Research		Variable Clusters	Examples
	5.3	Firm Development		□	□		None
	5.4	Contribution to Firm Development		□	□		None
	5.5	Alliance Evolution	N/A	(■)	(■)	Value effect of alliance formation and termination	Reuer/Miller (1997) Häussler (2006)

■ extensive/consistent evidence
(■) limited/moderately consistent evidence
□ no/inconsistent evidence

Table 72: Detailed Analysis of Event-Study Support for Theory-Based Propositions

Propositions		Value Effect	Environmental-Level Controls				Firm-Level Controls					Transaction-Level Controls			Documented Shortcomings
No.	Description		1	2	3	4	5	6	7	8	9	10	11	12	
1.1	Market-Power/ Collusive Alliances (Horizontal Relatedness/Ind. Conc.)	+	■	■			(■)								
1.2	Spillover Internalization/Standard. (R&D Collaboration)	+	■									■			
1.3	Market-Entry Alliances (Tech./Comm., Int. Barriers to Entry)	+	(■)	■	■							(■)			Limited Specific Evidence
1.4	Market-Entry Alliances (First Mover Advantages)	+	(■)	■	■							(■)			(outside of international collaboration)
1.5	Collaborative Competitive Advantages (Cost/Differentiation/Niche Positioning)	+	(■)									(■)			Dto.

Table 72 (Continued)

Propositions		Value Effect	Environmental-Level Controls				Firm-Level Controls					Transaction-Level Controls			Documented Shortcomings
No.	**Description**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
2.1	Complementary Technological Resources	+						■							
2.3	Social Capital (Personal/Organizational/Network)	+						■							
2.4	Transaction Experience								■						
2.5	Absorptive Capacity			(■)					□			□			Limited Evidence
3.1	Asset Specificity (R&D Collaboration/Investments)	–										(■)	■		
3.2	Environmental Uncertainty (Industry R&D Intensiveness)	–		(■)	■								(■)		
3.3	Transaction Scope	–										(■)	□		Limited Evidence
3.4	Coordination Costs (Prior Experience, Mimetic Behavior)	+			■				■						
4.1	Info Asymmetry (a) Management/Shareholders (b) Firm/Capital Market	–	■(b)				■(b)				■(a)			■(b)	
4.2	Information Asymmetry	–			■					■			■	■	
4.3	Contract Design	+													No Evidence
4.4	Trust	+			(■)					■					
4.5	Patent Protection	+	■												Limited Specific Evidence

Table 72 (Continued)

Propositions		Value Effect	Environmental-Level Controls				Firm-Level Controls					Transaction-Level Controls			Documented Shortcomings
No.	**Description**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
5.1	Environm. Change (a) Inducements for collaboration (b) Following Suit	+	■[(a)]			■[(a)]					■[(a)]				No Specific Evidence 5.1 (b)
5.2	Environmental Uncertainty	+	(■)			O									Limited Specific Evidence
5.3	Firm Development (Effect on Relevance of Alliances)	–				O	■				■			■	
5.4	Firm Development (Effect on Value of Specific Alliances)	+/–												■	
5.5	Alliance Evolution (Modification/ Termination/Internalization)	+/–													Termination/Internalization

+/– Positive/negative effect on collaborative value expected
■/(■)/□ Evidence supports proposition: Predominantly/Moderately/Not sufficiently

Table 73: Discussion of Further Shortcomings

Level	**Limitations**
Environment	Evidence on inter-industry variation in wealth effects is limited. On one hand, this may indicate appropriateness of pooling various industries, when analyzing the value impact of other explanatory variables. On the other hand, differences in value creation may exist at a level of aggregation other than standard industry classifications (SIC). These are generally based on technological differences and do not account for many market-related aspects. Contrarily, strategic groups may be more relevant for explaining differences in value creation.
Environment	Furthermore, as highlighted by Madhavan/Prescott (1995), the information value of corporate events may differ between industries (or strategic groups for that matter). This effect may mask the value creation and lead to a measurement bias in the abnormal return estimation. Consequently, information processing loads should be controlled for, provided that a conclusive proxy can be derived.

Environment	The competitive impact of strategic alliances has been studied much less extensively than that of other transactions, especially of course mergers and acquisitions. Nonetheless, it may prove to be a worthwhile object of study, at least for industry settings relying heavily on alliances as a strategic tool.
Institutional	First, the geographical scope of alliances has only been considered in few recent studies. While not being used as frequently for internationalization purposes as joint ventures, this aspect may influence an alliance's value creation. In this context, international alliances may on one hand be associated with significant costs of coordination. On the other hand, they may also provide access to more extensive complementary resources and networks than domestic alliances.
Institutional	Stock-market conditions have been shown to influence the valuation effects of mergers and acquisitions, in particular during the boom of the late 1990s and the subsequent market bust. Since alliances may also serve as sources of financing for smaller or financially strapped firms, their occurrence should be associated with different value implications depending on the availability of other outside financing opportunities. A similar arguments clearly also holds for different valuation levels of individual securities (e.g. measured by market-to-book ratios).
Firm	Prior research has exposed the relevance of corporate governance for the value impact of mergers and acquisitions. No such evidence exists regarding strategic alliances. In this context, both the governance structure of the firm under consideration as well as that of its alliance partner may be relevant. In particular, issues such as investment stakes and qualifications of board members may have an impact on the choice of value-enhancing cooperation partners and on the credibility of alliance formation among investors.
Firm	Other firm characteristics, in particular those pertaining to its financial stability and profitability, may be equally important. In particular, financially constrained firms may benefit from gaining access to otherwise unattainable resources. Conversely, they may be forced to share future profits with the alliance partner and be disadvantages in terms of bargaining power. Finally, such firms may gain significantly from the signal associated with respected alliance partners.

Firm	Findings on allying experience being a major influencing factor [cf. (Anand and Khanna 2000), Kale/Dyer/Singh (2001, 2002)] may need to be cross-validated. These studies consider the number of alliances and the establishment of an alliance management office as indicators of improved ability to extract value from alliances. At the same time, these proxies may be strongly related to the business model pursued by a given firm. Companies relying heavily on cooperation to achieve their goals should be more likely to formalize alliance management. Consequently, the reasons for their receiving higher abnormal returns than firms focusing less on allying may be diverse.
Transaction	Formal aspects of alliance structure have been largely neglected in value-oriented research. While different classifications such as licenses, cooperation agreements, and joint ventures have been touched upon [e.g. Koh/Ventakaram (1991)], a more detailed segmentation and their financial conditions still need to be addressed.

Table 74: Overview of Controls and Hypotheses for Empirical Analysis

Control	
Control 1:	Abnormal returns to strategic alliance (or JV) announcements may differ systematically across different industries or market segments.
Control 2:	The extent and type of relatedness between collaborating firms (and to the area of collaboration) may affect collaborative value creation.
Control 3:	International and domestic collaboration may differently affect firm value and partner origin may have a similarly discriminating effect.
Control 4:	Favorable environmental situations, in particular capital-market conditions, may be associated with reduced collaborative value creation.
Control 5:	The ARs to alliances and JV announcements may decrease with (absolute and/or relative) firm size.
Control 6:	Partner firms' technological, commercial, and social resources may positively affect the value created by collaborative agreements.

Control 7:	Focal firms' prior transaction experience may have a significantly positive value impact to new alliance formation announcements.
Control 8:	Prior relations between collaborating parties may increase collaborative value creation, unless they are overused.
Control 9:	Focal firm performance (in particular profitability) may reduce collaborative value.
Control 10:	Collaborative value creation may differ across functional alliance focuses, depending on the given alliance context.
Control 11:	The valuation effects of JVs and equity-based collaborative agreements may differ substantially from purely contractual ones.
Control 12:	The direction and extent of financial payments may affect the value created by collaborative agreements.
Hypotheses	
Hypothesis 1:	The abnormal returns to strategic alliance (and JV) formation are significantly positive.
Hypothesis 2:	The ARs to announcements of alliance (or JV) termination are significantly negative.
Hypothesis 3:	Announcements of alliance adaptation and progression exhibit significantly positive ARs.
Hypothesis 4:	Exploitation alliances are associated with higher ARs than exploration alliances.
Hypothesis 5:	Collaboration addressing (proprietary) drug-discovery yields higher AR than collaboration associated with other business models.
Hypothesis 6:	Alliances designed to leverage and capitalize on internal technological resources (i.e., 'outbound' direction of resource transfer) are associated with higher ARs than ('inbound') alliances attracting further resources.
Hypothesis 7:	The use of milestone and royalty payments increases collaborative value creation.
Hypothesis 8:	Limit duration of collaborative agreements decreases announcement AR, with the duration itself having a value-increasing effect.

Hypothesis 9:	Explicit flexibilities in alliance contracts have a positive impact on announcement AR.
Hypothesis 10:	The level of inter-firm activity at the industry level is positively related to the abnormal announcement returns on alliance formation.
Hypothesis 11:	The average volatility of the biotechnology sector increases the value of interorganizational collaboration.
Hypothesis 12:	Valuation effects of collaborative agreements will be stronger and more clearly associated with the above hypotheses.
Hypothesis 13:	Self-selection in alliance formation may mediate the value impact of environmental and firm-level variables.

Source: Own Compilation

Appendix to Chapter 4: Data and Empirical Methodology

Prior Event Study Methodologies

Table 75: Methodological Overview of Prior Event Study Research

Authors (Year)	(Expected) Return Model	Benchmark Index/Indices	Estimation Period	Event Period	Significance Tests / Cross-Sectional Methods
(McConnell and Nantell 1985)	Market model	(two-day re-turns)	+/– 180 to +/– 61	–1 to 0	Dodd-Warner Test Wilcoxon signed rank test
(Ravichandran and Sa-Aadu 1988)	Comparison period mean returns	N/A	–180 to –2 +1 to +60	–1 to 0	Significance Tests against comparison period returns (t, z)
(Lee and Wyatt 1990)	Market Model (CRSP Excess Returns)			+/–30, +/–5	Dodd-Warner Test
(Woolridge and Snow 1990)	Market-adjusted Returns	S&P 500	N/A	–1 to 0	Significance Tests
(Chen et al. 1991)	Market Model (CRSP Excess Return)		–150 to –30	Various (+/–10)	Brown-Warner Test
(Crutchley et al. 1991)	Market model / Market-adjustment	Unspecified	–130 to –31	–1 to 0	t-Tests
(Koh and Venkatraman 1991)	Market model		–270 to –71	–1 to 0	Significance Tests: t, z, Wilcoxon
(Hu et al. 1992)	Market Model (CRSP Excess Returns)		–150 to –30	+/– 5	t-Test
(Balakrishnan and Koza 1993)	Market model		months –72 to –13	months –12 to 0	z-Tests on Mean AR Seemingly unrelated GLS
(Cordeiro 1993)	Market model	Unspecified	–250 to –51	–1 to +1	Multivariate OLS
(Chung et al. 1993)	Market Model (CRSP Excess Return)		---	–60 to +30	Time-series Stan-dardized Test
(He et al. 1994)	Market model	Unspecified	–244 to –21	–20 to +5 / –1 to 0	Significance Tests on Mean AR (t) Multivariate OLS

Table 75 (Continued: 1995-2000)

Authors (Year)	(Expected) Return Model	Benchmark Index/Indices	Estimation Period	Event Period	Significance Tests / Cross-Sectional Methods
(Madhavan and Prescott 1995)	Market Model	Value-weighted index	–60 to –15	9 event windows	Dodd-Warner Test Wilcoxon signed rank test
(Mohanram and Nanda 1996)	Market Model		Months –60 to –12	–45 to +45	Significance Tests on Mean AR (t) Multivariate OLS
(Chan et al. 1997)	Market Model	Unspecified (value-weighted)	–170 to –21	–20 to 5	Significance Tests on Mean AR Multivariate OLS
(Park and Kim 1997)	Market Model	Market portfolio	–264 to –15	–2 to +1	Heteroskedasticity-adjusted GLS regressions
(Reuer and Miller 1997)	Market Model	Value-weighted Market Index	–250 to –50	–2 to +2	Dodd-Warner Test / Sign test Multivariate OLS
(Das et al. 1998)	Market Model	Unspecified (value-weighted)	–200 to –10	–3 to +3	Significance Tests on Mean AR and stock volatility
(Fröhls 1998)	Market Model	Unspecified	–120 to –21	0 to +1	Dodd-Warner Test / Wilcoxon Sign Test / Multivariate OLS
(Wu and Wei 1998)	Market Adjustment	Size-based Portfolios Fama/French (1992)]	N/A	–1 to 0	t-Tests Multivariate OLS
(Irwanto et al. 1999)	Market Model	Market Portfolio	–250 to –30	Various (+/–10)	Dodd-Warner Test
(Anand and Khanna 2000a)	Market model	S&P 500 (value-weighted)	–250 to –11	–10 to +3	One-way ANOVA Fixed-effects regression
(Chen et al. 2000)	Market model	Singapore All-Share (value-weighted)	–200 to –60	–1 to 0	Significance Tests (t, Wilcoxon) Multivariate OLS regressions
(Gupta and Misra 2000)	Market model	Unspecified	+/–150 to +/–16	–1 to 0	Significance Tests (z) Multivariate OLS/GLS reg.
(Houston and Johnson 2000)	Market model	CRSP (equal-weighted)	–170 to –21	–1 to 0	Significance Tests on Mean AR (z)
(Johnson and Houston 2000)	Market model	CRSP (equal-weighted)	–170 to –21	–1 to 0	Significance Tests on Mean AR (z)

Table 75 (Continued: 2000-2002)

Authors (Year)	(Expected) Return Model	Benchmark Index/Indices	Estimation Period	Event Period	Significance Tests / Cross-Sectional Methods
(Merchant and Schendel 2000)	Market model	Market (value-weighted)	–250 to –51	0 to +1	Significance Tests Multivariate OLS regressions
(Rajgopal et al. 2000)	Market Adjustment	NASDAQ equally weigh-ted Index	N/A	–1 to +1	GLS regression
(Reuer 2000)	Sharpe-Lintner Market model	Market Portfo-lio	–250 to –50	Day 0, +/–1	Significance Tests (t, Wilcoxon) ANOVA
Reuer (2001	Market Model	Value-weighted Mar-ket Index	–250 to –50	–2 to +2	t-test / Wilcoxon
(Reuer and Koza 2000a)	Market model	Unspecified (value-weighted)	–250 to –51	–1 to +1	Significance Tests on Mean AR
(Ueng et al. 2000)	Market model	Market	–150 to –30	+/–2, 3, 10	Significance Tests on Mean AR Multivariate OLS regressions
(Gulati and Wang 2001)	Market model	S&P 500 (equal-weighted)	–250 to –11	+/–1, +/–10	Multivariate OLS regressions
(Park and Martin 2001)	World-Market-Model	S&P 500 / Na-tional Market Indeces / Ex-change Rates	–259 to –10	–1 to +1	Radom-Effects Re-gression
(Neill et al. 2001)	Market model & Two-factor model	Unspecified indices: value-weighted / size-adjusted	–212 to –12	-1 to 0	Univariate & Multivariate OLS regressions
(Reuer 2001)	Market Model	Value-weighted Mkt Index	–250 to –50	–2 to +2	
(Bayona et al. 2002a, 2002b)	Market Model (dummy cor-rection for events in esti-mation period)	Ibex-35 Index	–126 to –6	+/–1, +/–2	Böhmer & Corrado Tests on AR, ab-normal volatility, trading volume, and liquidity
(Chang and Kuo 2002)	Market Model	Taiwan All-Share (value-weighted)	–200 to –31	3-day	Sign Tests / Differ-ence-of-Means Multivariate OLS regressions

Table 75 (Continued: 2002-2003)

Authors (Year)	(Expected) Return Model	Benchmark Index/Indices	Estimation Period	Event Period	Significance Tests / Cross-Sectional Methods
(Kale et al. 2001, 2002)	Market model	S&P 500 (value-weighted)	–190 to –11	–10 to +3	Multivariate OLS regressions
(Karamanos 2002)	Market ad-justment	FTSE All-Share Index	N/A	Day 0, +/–1, +/– 2	Significance Tests (t) Multivariate OLS regressions
(Kim and Park 2002)	Market model	Unspecified (local indices)	–260 to –10	day 0, –1 to +1	Significance Tests (z) Multivariate OLS regressions
(Merchant 2002)	see Merchant/ Schendel (2000)				
(Meschi and Cheng 2002)	Market Model	Leading na-tional indices (e.g. CAC40)	-160 to -11	Various (+/–10)	Brown-Warner z-Test
(Schut and Van Fredrikslust 2002)	Market model	Unspecified	–200 to –51	–1 to 0	Significance Tests on Mean AR Multivariate OLS regressions
(Yao and Ge 2002)	Market model	Unspecified	not reported	Various (+/–10)	Cluster regression with robust standard error
(Campart and Pfister 2003)	Market Model	Datastream Pharmaceutical / Nasdaq Bio-tech Indices	–210 to –11	+/–10, +/–5, +/–1	Significance Tests (t, nonparamet.) Multivariate OLS regressions
(Gleason et al. 2003)	Market Model	Equally-weighted market portfolio	–110 to –11	–1 to 0 / +/–1	Cross-Sectionally Standardized Signi-ficance Tests (also 6-/12-/-18 months)
(Hanvanich et al. 2003)	Market model	S&P 500	–150 to –10	–1 to +1	ANOVA
(Houston 2003)	Market model	CRSP (equal-weighted)	–170 to –21	–1 to 0	Significance Tests on Mean AR Wilcoxon Signed Rank Test Multivariate OLS regressions

Table 75 (Continued: 2003-2005)

Authors (Year)	(Expected) Return Model	Benchmark Index/Indices	Estimation Period	Event Period	Significance Tests / Cross-Sectional Methods
(Merchant 2003)	Market Model	Value-weighted Market Index	–250 to –51	0 to +1	ANOVA / MANOVA
(Sleuwaegen et al. 2003)	CAPM	Unspecified	75 days	–8 to 0	Significance tests (t, nonparametric), ANOVA
(Vidal Suarez and García-Canal 2003)	Market Model	Unspecified	–130 to –11	–2 to +2	Significance Tests on Mean AR Multivariate OLS regressions
(Brooke and Oliver 2004)	Market Model	ASX300 Accumulation Index	–250 to –20	3-/5-day windows	Brown Warner / ANOVA / Kruskal-Wallis Tests Uni-/Multivariate OLS
(Chang et al. 2004)	Market Model	NYSE/AMEX/ NASDAQ Index (equally weighted)	–200 to –60	+/–1	t-Test OLS regression
(Jones and Danbolt 2004)	Market Adjustment	Unspecified	N/A	Day 0	t-Test / Wilcoxon OLS regression
(Meschi 2004)	Market Model	CAC 40	–210 to –11	3, 7 & 11 days	OLS regression ANOVA
(Park 2004)	Market Model / World Market Model	Various	–259 to –10	+/–1	t-Tests
(Park et al. 2004)	Two-factor model (industry-adjusted)	NASDAQ All Share & MorganStanley Internet	–250 to –10	–1 to +1	Brown-Warner z-Test OLS / Random effects
(Piachaud and Muresan 2004)	Market Adjustment	FTSE All-Share Index	N/A	+/–10	Brown-Warner z-Test
(Wang and Wu 2004)	Market Model	Unspecified	–149 to –6	11 days / 3 days	Brown-Warner z-Test
(Burton 2005)	Market Model	FTSE Actuaries All-Share Index	–150 to –31	0 to +1	t-Test / Wilcoxon signed-rank test

Table 75 (Continued: 2005-present)

Authors (Year)	(Expected) Return Model	Benchmark Index/Indices	Estimation Period	Event Period	Significance Tests / Cross-Sectional Methods
(Chiou and White 2005)	Market Model	Unspecified	–219 to –20	–1 to 0	Z-Test OLS regression
(Hanvanich et al. 2005)	Market Model	S&P 500	–150 to –10	+/–1 day	OLS regression
(Häussler 2005, 2006) [, also (Socher 2004)]	Market Model	DAX/ NEMAX All-Share/ CDAX	–64 to –5	Day 0	OLS regression
(Huang and Chan 2005)	Market Model	Unspecified (Market Portfolio)	–150 to –31	Various (+/– 30)	t-Tests
(Park and Mezias 2005)	See (Park et al. 2004)				
(Higgins 2006)	Unspecified			+/–1 day	t-Test Multivariate OLS (Fixed Effects)
Subramaniana/ Gondhalekaraa/ Narayanaswamy (2006)	Fama-French three factor model	Market, size- and book-to-market adjusted portfolios	–200 to –50	+/–1, 5, 10, 20 days	t-Test / Wilcoxon sign-rank test
Suresh/Then-mozhi/Vijayara-ghavan (2006)	Market-adjusted Return Model	BSE Sensex	N/A	Various (+/–30)	Onw-Way ANOVA t-Test
(García-Canal and Sánchez-Lorda Undated)	Market Model	Unspecified	–200 to –21	+/–3 days	Brown-Warner z-Test Multivariate OLS
(Meschi et al. Undated)	Market Model	CAC40	–210 to –11	21 & 7 days	OLS regression ANOVA

Table 76: Methodological Overview of other Value-Related Research

Authors (Year)	Model Type	Index/Indices	Estimation Period	Event Period	Data Analysis
(Allen and Phillips 2000)*	Market model	Unspecified	–200 to –25	–10 to +10	Multivariate OLS regressions
(Janney and Folta 2003)*	Two-factor model (industry-adjusted)	Nasdaq composite Lerner (1994) biotechnology index	–250 to –30	–2 to +1	Two-stage Heckman selection model (ML estimation)
(Chang et al. 2004)	---	---	---	---	Partial Likelihood Hazard Model
(Folta and Janney 2004)	Market Model	Unspecified	–250 to –30	+/– 10, +/– 1, – 2/+1, – 1 to 0	Heckman Correction Model
(Hand 2004)	Log-linear Valuation	Financial Statement and other Information	N/A	N/A	OLS Regression

* studies refer to the value of alliances associated with block trades and private equity placements, respectively

Sample Selection Methodology

Table 77: Sources of Firm Classifications

Biocentury
Biocentury's "The Bernstein Report®" is a weekly journal (newletter) covering biotechnology industry developments, corporate performance and shareholder value. In particular, it provides stock performance information for over 500 public biotechnology firms worldwide.

BioScan
BioScan (a service of Thompson American Health Consultants) is a worldwide directory of biotechnology R&D firms including over 1800 entries. It includes firm-level information in general as well as information on products and transactions.

BioVenture

BioVenture View is a publication of PJB Publications Ltd covering current news regarding pharmaceutical and biotechnology R&D firms. In particular, it publishes a list of Europe's 50 largest biotechnology firms.

Ernst&Young

The consultancy Ernst&Young publishes a variety of written brochures on the biotechnology industry. Among other, European biotechnology reports have been published annually starting in 1997. These do not include one coherent list of European biotech firms, but cover a fairly large number of companies.

Recombinant Capital

Recombinant Capital is one of the most extensive sources of biotechnology industry information. Its constituency includes over 2700 biotechnology, pharmaceutical, and medical-device companies.

Industry Associations

European biotechnology firms may be members of national (e.g., DIB in Germany), European (Eurobio) or global (Bio) biotechnology industry associations. At the same time, membership in these associations is not limited to pure-play biotechnology companies. Consequently, their membership directories also include big pharma firms, research institutes and universities, as well as occasionally venture capital firms investing in biotechnology.

Stock Exchanges

Most European stock exchanges provide industry-classifications of listed companies. However, not all stock exchanges do so, and it is rather difficult to assess the acceptance of such classifications in the industry.

Table 78: Use of Biotechnology Industry Classifications in Prior Academic Literature

Article	BioScan	Recom-binant Capital	Biospace	NCBI	Other Biotech	Other General
(Audretsch and Feldman 1996)	■	■			IBI	MERIT-CATI
Chang/Garen (2001)	■					
(Champenois et al. 2004)					BioCom	
Danzon/Epstein/ Nicholson (2003)						S&P Compustat Merrill Lynch
Folta/Ferrier (2000)	■			■		
(Hand 2004)	■					
(Hand 2001)		■	■		Robins-Roth	Nasdaq/Amex
Higgins/Rodriguez (2005)						SDC /WSJ
(Lerner and Merges 1998)		■				
(Liu 2000)					Zucker/ Darby	LexisNexis
(Niosi 2003)					Bio-TeCanada	
Oliver (2001)				■		
Qian/Li (2003)	■				Ernest&Y oung	
Shan/Walker/Kogut (1994)	■					
Stuart/Hoang/Hybels (1999)	■	■		■		SDC
Zahra/George (1990)	■			■	Office of Technol-ogy Assess-ment	Various Newspapers
Zucker/Darby (1996)	■					Moody's
Zucker/Darby/ Brewer (1998)	■			■		

Source: Own Compilation

Table 79: Number of Firms Identified by Different Biotechnology Industry Classifications/Listings

	Bio Century	**BioScan**	**Bio Venture**	**E&Y Reports**	**ReCap**	**Assoco-ciation Members**	**Stock Exchanges**
BC	**109**						
BS	62 **47** 12	**59**					
BV	56 **53** 1	20 **39** 15	**54**				
EY	50 **59** 8	20 **39** 28	8 **46** 21	**67**			
RC	23 **86** 9	18 **41** 54	11 **43** 52	9 **53** 42	**95**		
AS	82 **27** 12	38 **21** 18	34 **20** 19	46 **21** 18	71 **24** 15	**39**	
SE	66 **43** 5	35 **24** 24	26 **28** 20	36 **31** 17	57 **38** 10	35 **4** 44	**48**

Number in center of cell: No. of firms included in both listings
Number at top right: No. of firms listed only in the column listing (i.e. listing total – overlap)
Number at bottom left: No. of firms listed only in the row listing (i.e. listing total – overlap)

Derivation of Centrality Measure and Efficiency Measures

I Centrality Measure

The derivation of an aggregate centrality measure for a given listing (i) is based on its contribution to the (degree) centrality of another listing (j) within the overall network of constituents (i.e., firms). Equation

(2)
[p. 155]

$$C_j^A = \frac{1}{(J-1)} \cdot \sum_{j=1}^{J-1} \frac{k_{i \cup j}}{k_j}$$

is derived by averaging the relative centrality measure $C_{i\,|\,j}$ indicating the share of another listings constituency in consensus (i.e., overlapping) with the focal one [equation (20a)]:

(20a) $$C_{i|j} = \frac{C_{i \cup j}}{C_j} = \frac{\frac{k_i \cup k_j}{K-1}}{\frac{k_j}{K-1}} = \frac{k_i \cup k_j}{k_j}$$

with:

$C_{i\,|\,j}$	=	Relative Centrality Measure for Listing i with regard to Listing j
C_{iUj}	=	Centrality Measure for Intersection of Listings i and j
C_j	=	Centrality Measure for Listing j
k_{iUj}	=	Number of Constituents included in both Listings i and j
k_j	=	Number of Constituents included in Listing j
N-1	=	Total Number of Constituents (Firms) in the Overall Network

across all (N-1) alternative listings as shown in (20b):

(20b) $$C_j^A = \frac{1}{(J-1)} \cdot \sum_{j-1}^{J-1} C_{i|j}$$

with:

C^A_i	=	Aggregate Centrality Measure for Listing i with regard to all other Listings
$C_{i\,|\,j}$	=	Relative Centrality Measure for Listing i with regard to Listing j
J	=	Total Number of Listings

II Efficiency Measure

The derivation of an aggregate efficiency measure for a given listing (i) is based on the congruence of its (degree) centrality with that of another listing (j) within the overall network of constituents (i.e., firms). Equation

(3) [p. 155] $$E_i = \frac{1}{(J-1)} \cdot \sum_{j-1}^{J-1} \frac{k_{i \cup j}}{k_i}$$

is derived by averaging the relative efficiency measure $E_{i\,|\,j}$ as derived in equation (21a)

(21a) $$E_{i|j} = \frac{C_{i \cup j}}{C_i} = \frac{\frac{k_i \cup k_j}{K-1}}{\frac{k_i}{K-1}} = \frac{k_i \cup k_j}{k_i}$$

where:

$E_{i\,|\,j}$	=	Relative Efficiency Measure for Listing i with regard to Listing j
C_{iUj}	=	Centrality Measure for Intersection of Listings I and j
C_i	=	Centrality Measure for Listing i
k_{iUj}	=	Number of Constituents included in both Listings i and j
k_i	=	Number of Constituents included in Listing i
K-1	=	Total Number of Constituents (Firms) in the Overall Network

across all (N-1) alternative listings as shown in (21b):

(21b) $$E_j^A = \frac{1}{(J-1)} \cdot \sum_{j=1}^{J-1} E_{i|j}$$

where:

C^A_i	=	Aggregate Centrality Measure for Listing i with regard to all other Listings
$C_{i\,|\,j}$	=	Relative Centrality Measure for Listing i with regard to Listing j
J	=	Total Number of Listings

III Foundation

Both measures are founded on the general measure of degree centrality, which is defined [e.g., by (Freeman 1978/79) and (Latora and Marchiori 2004)] as:

(22) $$C_i = \frac{k_i}{K-1} = \frac{\sum_{k=1}^{K-1} a\left(p_i, p_k\right)}{K-1}$$

where:

$a\,(p_i, p_k)$	=	binary variable taking the value of 1 if point i in the network is linked to point k (i.e., firm i is included in listing j)

Table 80: Analysis of Contribution to Sample Selection

Source	No. of Firms	Effectiveness Measure	Efficiency Measure
Total	141	___	___
Biocentury	109	85.87%	48.17%
ReCap	95	74.64%	50.00%
Ernst&Young	67	63.27%	61.94%
Bioventure	54	56.38%	70.68%
BioScan	59	53.43%	59.60%
Stock Exchange	48	38.08%	58.33%
Industry Assoc.	39	27.06%	50.00%

Source: Own Analysis

Table 81: Overview of Selection Algorithms

Cutoff	Firms	% of Max.	ANL[566]	% of Max.	Conclusion
1/5	**131**	**100%**	**2.93**	**59%**	Excludes those entities only constituent of Biotechnology Associations or Stock Exchange Classifications (10)
2/5	**108**	**82%**	**3.34**	**67%**	Eliminates all firms merely being falsely included in one main source (23)
3/5	**68**	**52%**	**4.13**	**83%**	Increases confidence by dropping firms not in >50% of relevant listings (40)
4/5	**46**	**35%**	**4.67**	**93%**	Further increasing required overlap eliminates constituents not widely considered biotechs (ANL > 90% of maximum)
5/5	**31**	**25%**	**5.00**	**100%**	Full consensus eliminates firms not considered core industry players by all market participants (15)

Shaded area: Selection mechanism used in present study
Source: Own Analysis

566 ANL indicates the average number of listings in which sample firms are included under each selection algorithm.

Table 82: Overview of (Final) Sample Firms

Company Name	Stock Exchange	ISIN	IPO Date
Acambis	London	GB0006941792	30-Nov-95
Actelion N	Zurich	CH0010532478	06-Apr-00
Active Biotech ser.A	Stockholm	SE0001137985	
Alizyme	London	GB0000374289	19-Oct-00
Antisoma	London	GB0055696032	16-Dec-99
Bavarian Nordic	Copenhagen	DK0015998017	Nov-98
Berna N	Zurich	CH0014298019	04-Jun-02
Cambridge Antibody Techn.	London	GB0001662252	25-Mar-97
Celltech	London	GB0001822765	Dec-93
Cenes Pharmaceutical	London	GB0002070505	Aug-03
Cerep S.A.	Paris	FR0004042232	Feb-98
Crucell	Amsterdam	NL0000358562	27-Oct-00
Cytos Biotechnology AG	Zurich	CH0011025217	29-Oct-02
deCODE genetics Inc.	EASDAQ	US2435861040	Jul-00
Evotec OAI	Frankfurt	DE0005664809	11-Nov-99
Genmab A/S	Copenhagen	DK0010272202	18-Oct-00
GPC Biotech AG	Frankfurt	DE0005851505	31-May-00
Innogenetics	Brussels	BE0160220738	11-Dec-02
IsoTis N	Zurich	CH0012572522	09-Jul-01
K S Biomedix Holdings	London	GB0004796669	
Karo Bio	Stockholm	SE0000571416	03-Apr-98
LION Bioscience	Frankfurt	DE0005043509	11-Aug-00
Medigene NA	Frankfurt	DE0005020903	30-Jun-00
Mologen Holding	Frankfurt	DE0006637200	17-Jul-98
Morphosys AG	Frankfurt	DE0006632003	10-Mar-99
NeuroSearch A/S	Copenhagen	DK0010224666	1996
Nicox	Paris	FR0000074130	03-Nov-99

Table 82 (Continued)

Company Name	Stock Exchange	ISIN	IPO Date
November AG	Frankfurt	DE0006762909	10-Apr-00
Novuspharma SpA	Milano	IT0001482444	
Oxford Glycoscience	London	GB0002647328	
Pharmagene	London	GB0009231639	31-Jul-00
Pharming	Amsterdam	NL0000377018	Jun-99
Phytopharm	London	GB0006869720	25-Apr-96
Powerject	London	GB0000418383	
PPL Therapeutics	London	GB0006657448	1996
Protherics	London	GB0007029209	06-Dec-96
Provalis	London	GB0001460897	15-Dec-97
PyroSequencing A	Stockholm	SE0000454753	Jun-00
Qiagen	Frankfurt	NL0000240000	25-Sep-97
Serono -B- I	Zurich	CH0010751920	26-May-00
Shire Pharmaceuticals	London	GB0007998031	20.03.2000
SkyePharma	London	GB0008123571	03-May-96
Transgene	Paris	FR0005175080	1998
Vernalis Group	London	GB0032750324	09-Jul-92
Weston Medial	London	GB0003821625	May-00
Xenova	London	GB0009850008	Dec-96

Source: Own Analysis

Table 83: Manual Reviews of Final Firm Sample

Industry Segment
Biotechnology firms may apply their technologies towards other applications than human health (i.e., 'red biotechnology'). Consequently, company reports and websites were reviewed to ensure that no sample firm was focusing its activities on other biotechnological applications.
Company Origin
Firm records were reviewed for the location of company headquarters, since some of the listings used are global in nature and non-European firms may have secondary placements on Europe stock exchanges.[567]
Data Availability
Event studies generally exclude firms for whom stock data is unavailable or grossly incomplete [e.g. Brown/Warner (1983)]. However, no firm lacked such information across the entire period of study, allowing to defer such exclusions to the individual transaction level (as is common practice).

[567] While no revisions were necessary for the concise sample (requring 4 out 5 listings), three such firms were included in the less restrictive sample (only 3 out of 5 listings) and would consequently have to be dropped, bringing that samples size to 65 firms. One firm, Oxigene (not included in final sample), moved its company headquarters from Sweden to the U.S.. Another, Quiagen (included in the final sample), first listed on NASDAQ (1996) before also listing on the German Neuer Markt (1997). The company was retained for the time period following its Neuer Markt listing.

Table 84: 3-Step Procedure for Retrieving Sample Event Announcements

Step	Description	No of Events
1	The LexisNexis database was searched for news announcements based on the focal firms' name or a sufficiently distinctive fraction thereof. While using the full company names would have ensured that only news relating to the focal firms were returned, many newswires abbreviate firm names. Additionally, the search was limited to the pharmaceutical industry where required to avoid confusion with other firms.	approx. 10'000
2	All events not containing news regarding the focal firms were eliminated. Such corrections were necessary, since focal firm names may appear in announcements related to stock indices (in which they are included) and announcements by collaborating or otherwise related firms. Similarly, multiple items transferring the same piece of news on or close to the same day as the initial report were dropped.	2'572
3	News announcements were classified as containing information on collaborative activities as opposed to other types of potentially relevant news. While only alliance-related announcements were to be included in the final sample, other news items may represent confounding events and would reduce the reliability of findings, if they were not corrected for.	690 (plus 50 items announced while firms not listed)

Table 85: Sample Construction Accounting for Confounding Events

Event Window	All Alliance Related Events			Alliance Formation Events		
	Included	Con-founded	Share	Included	Con-founded	Share
Total	690			379		
Day 0[568]	616	57	8,3%	335	32	8,4%
2-day	599	91	13,2%	328	51	13,5%
3-day	568	122	17,7%	311	68	17,9%
5-day	528	162	23,5%	290	89	23,5%
11-day	431	259	37,5%	243	136	35,9%
21-day	280	410	59,4%	161	218	57,5%

Source: Own Analysis

568 In addition to confounded events, another 17 alliance-related (12 alliance formation) announcements were excluded due to missing stock return data. In contrast, no return series were void for longer event windows.

Table 86: Overlap Between DGAP and LexisNexis Announcements (number of announcements)

(Sub-)Sample	Total No. of Firms	In both	Only in DGAP	Only in Lexis Nexis
All Events	682	334	75	273
Collaboration	242	120	9	113
Other	440	214	66	160

Source: Own Analysis

Table 87: Timing Difference Between DGAP and LexisNexis Announcements (absolute number of days)

(Sub-)Sample	Same	1 day	2 days	3 days	4-5 days	6-7 days	> 7 days
All Events	294	23	4	2	7	2	2
Collaboration	110	3	1	2	2	0	2
Other	184	20	3	0	5	2	0

Source: Own Analysis

Table 88: Overlap Between ReCap and LexisNexis Announcements (number of announcements)

Total No. of Items	In both	Only in ReCap	Only in Lexis Nexis
713	316	314	83

Source: Own Analysis

Table 89: Timing Difference Between ReCap and LexisNexis Announcements (in number of months)

<table>
<tr><th>Direc-tion</th><th>No Differ-ence</th><th>Any Differ-ence</th><th>1 month</th><th>2-3 months</th><th>4-6 months</th><th>>6 months</th></tr>
<tr><td>Earlier</td><td rowspan="2">269</td><td>31</td><td>23</td><td>6</td><td>1</td><td>1</td></tr>
<tr><td>Later</td><td>16</td><td>8</td><td>2</td><td>5</td><td>1</td></tr>
</table>

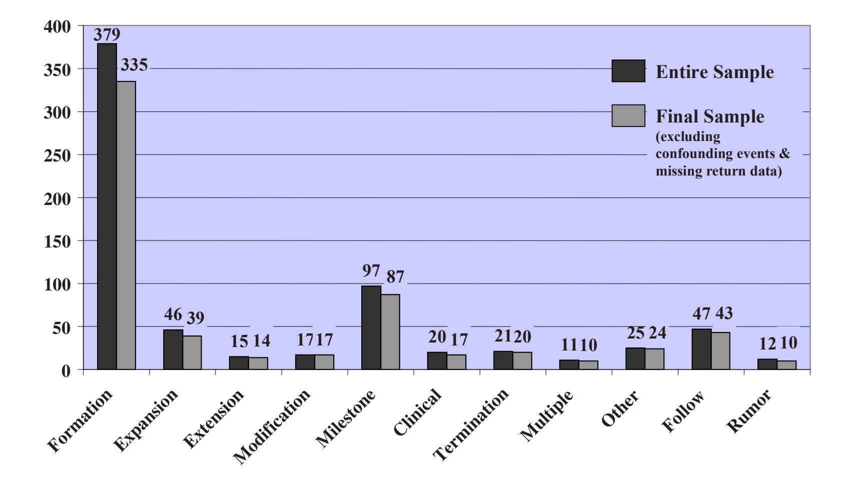
Source: Own Analysis

Data Coding Methdology

Table 90: Coding of Alliance-Related News

Transaction Type	Definition	Including
Hypothesized Effects (Substantive)		
Formation	Announcement of new collaboration	Alliances between previously related partners
Expansion	Announcement of increase in the scope of alliance activities	Joint expansion and extension
Extension	Announcement of Prolongation (with largely unaltered scope)	
Modification	Announcement of changes to the structure/terms of the alliance without extension or expansion of activities	
Milestone	Announcement of collaborative achievements (e.g. research results)	Natural end point of alliance
Clinical / Advancement	Announcement of collaborative activities (e.g. entry into clinical trials)	
Termination	Announcement of premature end of collaborative activities (i.e., not satisfaction of collaborative objective)	Non-exercise of existing options (especially to expand or extend collaboration)
Complementary Events and Non-Substantive News		
Other	Announcement of activities akin to collaboration or not related to human health (red biotechnology)	Asset Sales Environmental Protection / Animal Health / Agriculture
Multiple	Announcements on multiple unrelated alliances	
Rumor	News on potential alliance formation (or other alliance-related activities)	
Follow	Reiteration of already published information on alliance formation (or other alliance-related activities)	

Figure 54: Breakdown of Sample Events by Type



Data Source: Own Analysis

Table 91: Industry-Specific Classification of Medical Indications

Indication	PHRMA (2002)	IMS (2000)	Goldman Sachs (2001)	DZ Bank (multiple)	EIB (2002)	Ernst& Young (multiple)	Total Number of Classi-fications
Allergies & Asthma	□	□	□	■	□	■	2
Autoimmune Disorders	■	□	□	□	□	■	2
Blood Disorders	■	□	□	■	□	■	3
Cancer	■	■	■	■	■	■	6
Digestive Disorders	■	■	□	■	□	■	4
Eye Conditions	■	□	□	■	□	■	3
Genetic Disorders	■	□	□	□	□	■	2
Growth Disorders	■	□	□	□	■	□	2
Heart Diseases	■	■	■	■	■	■	6

Table 91 (Continued)

Indication	PHRMA (2002)	IMS (2000)	Goldman Sachs (2001)	DZ Bank (multiple)	EIB (2002)	Ernst& Young (multiple)	Total Number of Classi-fications
Infectious Diseases	■	■	■	■	□	■	5
– AIDS/HIV	■	□	□	■	□	■	3
– Hepatitis	□	□	□	■	■	□	2
Infertility	■	■	■	□	□	■	4
Inflammation	□	□	■	■	■	■	4
Metabolic Diseases	□	■	■	■	□	■	4
– Diabetes	■	□	□	■	■	■	4
– Osteoporosis	□	□	□	■	■	□	2
Muscle/Skeletal	□	■	□	□	□	■	2
Neurological Disorders	■	■	■	■	□	■	5
– Alzheimer	□	□	□	□	■	■	2
– Parkinson Disease	□	□	□	□	■	■	2
Respiratory Disorders	■	■	■	■	□	■	5
Skin Disorders	■	■	□	■	□	■	4
Transplantation	■	□	□	□	□	■	2
Vaccines/ Adjuvants	□	□	■	□	□	■	2

■ (□) Indication is (not) included in given classification scheme
Shaded area: Indications distinguished in present study

Table 92: Classifications of Medical Indications Used in Academic Research

Indication	**Matraves (1999)**	**Tapon/Thong/Batrell (2001)**	**Breitzman/Thomas (2002)**
Allergies & Asthma			Allergy
Autoimmune Disorders			Immune-Related
Blood Disorders			
Cancer	Cancer Therapy	Cancer	Oncology
Digestive Disorders	Internal Medicine		Gastrointestinal
Eye Conditions		Ophthalmic	Vision
Genetic Disorders			
Growth Disorders			
Heart Diseases	Cardiovascular	Cardiovascular	Cardiovascular / Stroke
Infectious Diseases	Anti-Infectives	Infections (Hepatitis, AIDS, Anti-Viral)	Infectious Diseases / Viral / HIV
– AIDS/HIV			
– Hepatitis			
Infertility			Fertility / Sexual Dysfunction
Inflammation		Anti-Inflammatory	Inflammation
Metabolic Diseases		Metabolism/Osteoporosis/Hormones	
– Diabetes			Diabetes
– Osteoporosis			Menopause / Osteoporosis
Muscle/Skelettal			
Neurological Disorders	Mental Health / Central Nervous System	Central Nervous System	Central Nervous System / Psych. Disorder
– Alzheimer			
– Parkinson Disease			

Table 92 (Continued)

Indication	Matraves (1999)	Tapon/Thong/Batrell (2001)	Breitzman/Thomas (2002)
Respiratory Disorders	Respiratory System		Respiratory
Skin Disorders	Topical		Skin
Transplantation			
Vaccines/ Adjuvants			
Other	Pain Control Miscellaneous	Other Diagnostics Transplantation	Pain Kidney/Renal Prostate

Shaded area: Indications distinguished in present study

Table 93: Coding of Functional Alliance Objectives

Functional Area	Definition	Including
Research & Development		
– Research	Activities geared towards the discovery of novel drugs (prior to preclinical stage)	– Screening of partner targets in proprietary assays
– Development	Activities geared towards development and testing of drugs (preclinical stage or later), platform technology or other products (e.g. diagnostics)	– Development of production procedures
– Technology Transfer	Transfer of abstract, i.e. not directly marketable/applicable, technology	– Licensing of patents
Manufacturing	Physical production of platform technology or product (drug/diagnostics/other)	– Contract manufacturing – Joint Manufacturing
Commercialization		
– Supply	Provision of (rights to) platform technology or product (drug/diagnostics/other) for in-house use	– Sequencing of screening assays/libraries – Supply of vaccines to governments
– Marketing	Provision of (rights to) platform technology or product (drug/diagnostics/other) for external sale	– Licensing of marketing rights
Other/Unspecified	Activities not included in one of the above categories	– PR/Consulting services agreements

Table 94: Classifications of Pharmaceutical Development Stages

<table>
<tr><th>Meta-Stage</th><th>Stage</th><th>Lerner/ Merges (1997, 1998)</th><th>(Hand 2001)</th><th>Robinson/ Stuart (2002)</th><th>Lerner et al. (2003)</th><th>(Rothaermel and Deeds 2004)</th><th>Goldman Sachs (2001)</th><th>Deutsche Bank (2004)</th></tr>
<tr><td rowspan="4">Pre-Clinical</td><td>Basic Research</td><td></td><td></td><td></td><td></td><td rowspan="4">Exploration</td><td></td><td></td></tr>
<tr><td>Target Identification/Validation</td><td rowspan="2">Discovery / Lead Molecule</td><td rowspan="2">Discovery</td><td>Discovery-Stage Research</td><td>Discovery</td><td rowspan="3">Pre-Clinic</td><td rowspan="2">R&D</td></tr>
<tr><td>Lead Screening/Optimization</td><td>Lead-Molecule Stage</td><td>Lead Molecule</td></tr>
<tr><td>Pre-Clinical Development</td><td>Pre-Clinical Development</td><td>Pre-Clinical Testing</td><td>Pre-Clinical</td><td>Pre-Clinical</td><td>Pre-Clinic</td></tr>
<tr><td rowspan="3">Clinic</td><td>Clinical Phase I</td><td rowspan="4">Regulatory Review</td><td rowspan="3">Clinical Phase</td><td rowspan="3">Clinical Tests</td><td rowspan="2">Clinical Phases I & II</td><td rowspan="5">Exploitation</td><td>Clinical Phase I</td><td>Clinical Phase I</td></tr>
<tr><td>Clinical Phase II</td><td>Clinical Phase II</td><td>Clinical Phase II</td></tr>
<tr><td>Clinical Phase III</td><td rowspan="2">Clinical Phase III & Final Review</td><td>Clinical Phase III</td><td>Clinical Phase III</td></tr>
<tr><td rowspan="2">Post-Clinic</td><td>Registration</td><td>FDA Review & Approval</td><td rowspan="2">Unspecified</td><td>Registration</td><td>Application for Approval</td></tr>
<tr><td>Commercialization</td><td>Approved</td><td>Post-Marketing Testing</td><td>Unspecified</td><td>Commercialization</td><td>Market Entry</td></tr>
</table>

Table 95: Coding of Stages of Product Development Stages

<table>
<tr><th></th><th>Stage</th><th>Description/Prerequisites</th><th>Including</th><th>Final Coding</th></tr>
<tr><td>0</td><td>Unspecified</td><td>Collaboration not associated with one/several given development stages</td><td></td><td rowspan="5">Exploration</td></tr>
<tr><td>1</td><td>Basic Research</td><td>Research not directly associated with particular application, i.e. drug, technology or other product</td><td>Genotyping, i.e. deciphering genome</td></tr>
<tr><td>2</td><td>Target Identification</td><td>Search for target structures linked to targeted medical indication</td><td>Genomics</td></tr>
<tr><td>3</td><td>Target Validation</td><td>Validation of linkage between target structure and targeted indication</td><td></td></tr>
<tr><td>4</td><td>Lead Screening</td><td>Development of lead compound(s) showing activity on validated target structures</td><td></td></tr>
</table>

Table 95 (Continued)

	Stage	Description/Prerequisites	Including	Final Coding
5	Lead Optimization	Optimization of pharmacological profile of lead compound(s) having shown activity on target	Molecular modeling / Combinatorial Chemistry (ADME characteristics)	
6	Preclinical Development	Lead compounds being tested in animal models and/or being prepared for clinical trials (IND status)	Drug Delivery" reformulation of already marketed) compounds	
7	Clinical Phase 1	Small-sample studies testing toxicity and optimal dosing scheme of drug candidate		
8	Clinical Phase 2	Medium-sample studies testing in vivo effectiveness of drug candidate		
9	Clinical Phase 3	Large-sample studies testing in vivo efficacy		
10	Registration	Review of documentation against efficacy benchmark to gain approval		
11	Commercialization	Production and marketing of approved drugs		Exploitation
12	Technology/ Other Product Development	Technology/Diagnostics/Other Products requiring further development prior to market introduction	Sequencing of Screening Assays/ Libraries (for partner's use)	
13	Technology/ Other Product Commercialization	Technology/Diagnostics/Other Products already being commercialized (via alliance/s or in open market)	Supply of standardized platform technologies Access to existing compound libraries	

Table 96: Coding of Business Models Pursued via Alliance

Business Model	**Definition**	**Including**
Drug Discovery	Collaboration involving one party's existing drug candidate(s) or joint drug development	– In-/Outlicensing of existing Drug Targets & Candidates – Collaborative Development of existing Drug Candidates
Platform Technology	Development and commercialization of proprietary technologies (to be used in the R&D process)	– Drug Libraries/Screening Assays
Service	Application of proprietary technologies with regard to partners' drug pipeline (only affecting limited number of stages in drug discovery/development process)	– Lead Screening on Partner Targets (for partner) – Targets Identification (for partner's further use) – Contract Manufacturing
Diagnostics	Development and commercialization of products for diagnosis of medical conditions	
Hybrid	Products and Services that may be assigned to several of the above categories	
Other	Products and Services not assigned to any of the above categories	

Table 97: Coding of the Direction of Resource Transfer

Functional Focus	**Definition**	**Including**
Inbound	Exploitation of partner firms' Drug/Technology/Service/Product (⇔ previously partners' property rights)	In-licensing Client of Service Provision
Outbound	Exploitation of focal firm's Drug/Technology/Service/Product (⇔ previously own property rights)	Out-licensing Service Provider
Joint	Drug/Technology/Service/Product (equitably) developed/commercialized by both (all) partners [bilateral exploration]	Joint Drug/Technology Development
Cross	Drugs/Technologies/Services/Products reciprocally exchanged among both (all) partners [bilateral exploitation]	Cross-licensing Combinations of in- and outbound transfers/services

Table 98: Coding Alliance Compensation Components

Type of Compensation	Definition	Including
Guaranteed Payments	Payments guaranteed in the contract, payable immediately or over duration of collaboration	Upfront Payments Research Funding License/Technology Access Fees
Milestone Payments	Payments dependent on collaborative progress made (e.g. entry into subsequent development stage)	
Royalties	Payments dependent on commercialization of final product	Revenue Sharing Commercialization Rights

Table 99: Coding of Structural Alliance Characteristics

Type of Contract	Definition	Including
Equity Investment	Agreement to take equity stake in (respectively) other firm	Convertible Preferred Equity/Debt Stock-Purchase Options
Joint Venture	Formation of joint subsidiary irrespective of relative ownership stakes (NOT use of term JV)	
Time-Limitedness	Agreement has a prespecified duration, upon which it ends or must me prolonged	
Contract Duration	Specific duration of time-limited agreement as reported (in months)	
Explicit Optionality	Explicit flexibility to alter duration, scope or structure of collaboration	Convertible Preferred Equity/Debt Stock-Purchase Options Option to Extend/Expand/ Convert Alliance
License	Explicit right to technology or product for further development and/or commercialization	

Figure 55: Standardized 200-Day Return and (Normalized) Volatility Measures for Stoxx Biotechnology All-Share Index

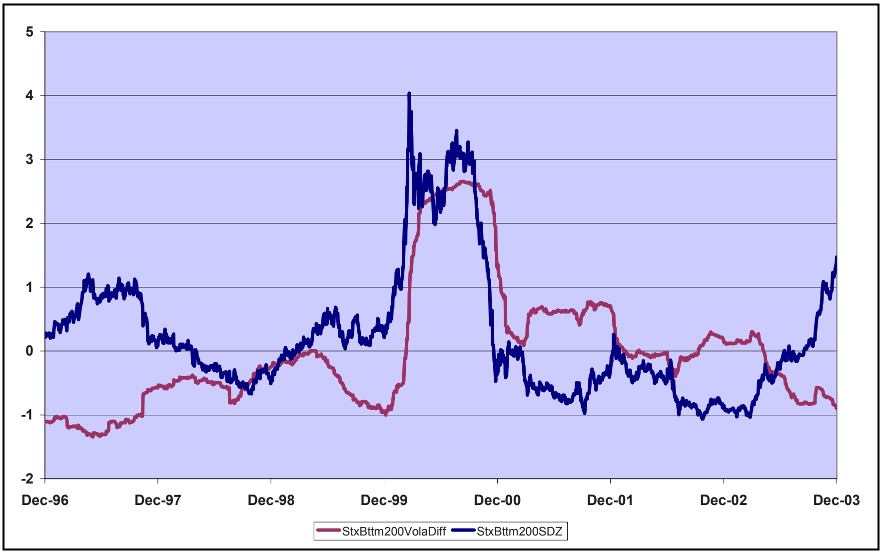


Figure 56: Standardized and Normalized 12-Month Market Activity Measure

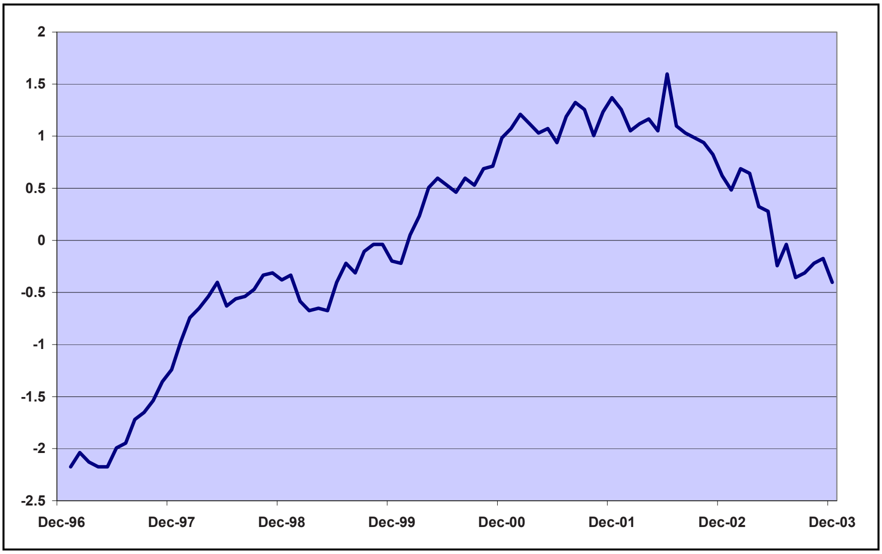
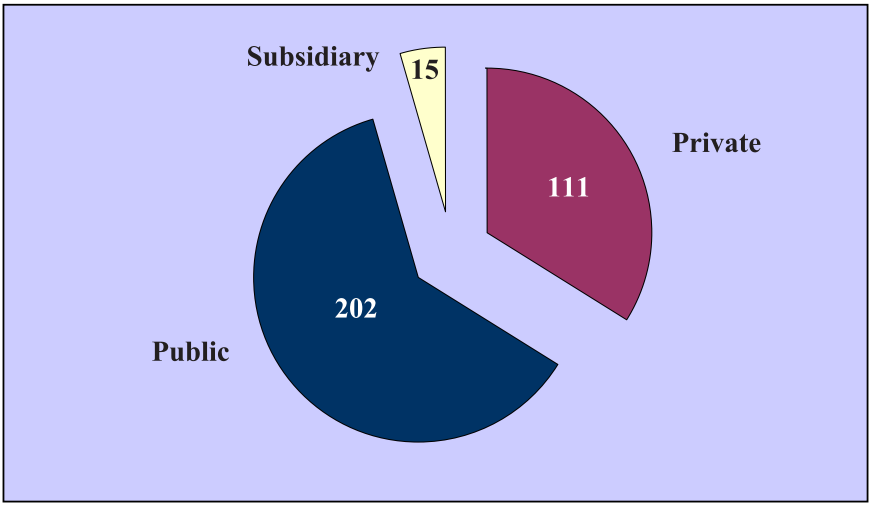


Figure 57: Comparison of Biotechnology and General Market Returns and Volatilities

(a) 200-Day Returns on Stoxx Biotech Total Market Index versus Stoxx 600 Index

(b) 200-Day Volatility of Stoxx Biotech Total Market and Stoxx 600 Indices

Figure 58: Overview of Partner-Firm Status [N=328]



Data Source: Own Analysis

Table 100: Overview of Controls and Associated Variables used in Present Study

Control	Key Concepts	Measures/Variables	Type of Variables
Control 1	Industries/Market Segments	Medical Indication	Binary
Control 2	Relatedness	Partner Firm Type - Pharmaceutical - University/Research Institute - Biotech Firm - Other	Binary
Control 3	International Dimension	Partner Firm Origin - North America - Europe - Other	Binary
Control 4	Environmental Conditions	200-day Intra-Sample Return	Continuous
Control 5	Focal Firm Size	Focal Firm - Sales - Assets - No. of Employees - Market Value	
Control 6	Partner Firm Resources	Partner Firm Patent Count Partner Firm Public/Private Status Partner Firm Alliance Count	Discrete Binary Discrete
Control 7	Focal Firm Alliance Experience	Focal Firm Alliance Count	Discrete
Control 8	Intra-Alliance Trust	Prior Partner Relations	Binary
Control 9	Focal Firm Performance	EBIT Net Cashflows Tobin's q	Continuous
Control 10	Functional Focus	Research & Development Manufacturing Commercialization	Binary
Control 11	Organizational Structure of Alliance	Contractual Agreement Licensing JV / Equity Investment	Binary
Control 12	Direction and Extent of Payments	In-/Outbound Payments Transaction Value	Binary Continuous

Source: Own Compilation

Table 101: Overview of Hypotheses and associated Variables Used in Present Study

Hypotheses	**Approach**	**Measures/Variables**	**Type of Variables**
Hypothesis 1	Event Study	Abnormal Returns on Formation Announcements	N/A
Hypothesis 2	Event Study	Abnormal Returns on Termination Announcements	N/A
Hypothesis 3	Event Study	Abnormal Returns on Modification Announcements	N/A
Hypothesis 4	Multivariate Regression	Stage of Development (a) Exploration (b) Exploitation)	Binary
Hypothesis 5	Multivariate Regression	Collaborative Business Model: (a) Drug Discovery (b) Services, Platform (c) Technologies	Binary
Hypothesis 6	Multivariate Regression	Direction of Technological Resource Transfer: (a) Inbound, (b) Outbound, (c) Joint/Cross)	Binary
Hypothesis 7	Multivariate Regression	Compensation Structure	Binary
Hypothesis 8	Multivariate Regression	Time-Limitedness and Duration of Collaboration	Binary/ Continuous
Hypothesis 9	Multivariate Regression	Explicit Option Rights	Binary
Hypothesis 10	Multivariate Regression	Alliance Activity Index (12-month Transaction Count)	Continuous
Hypothesis 11	Multivariate Regression	Market Volatility (200-day Intra-Sample Stock Return Volatility)	Continuous
Hypothesis 12	Split-Sample Approach	Distinct effects on value of smaller/larger firms	N/A
Hypothesis 13	Two-Stage Selection Model	Effect of self-selection on value creation	N/A

Source: Own Compilation

Table 102: Overview of Alternative Measures

Used	**Alternative Specifications**	**Data Type**
Firm Size	Firm Age - Time since Foundation (in years) - Time since IPO (in months)	Discrete*
Medical Indication	- Market Size (per Indication) - No. of Products under Development (per Indication)	Continuous* Discrete*
Development Stage (see Table 94)	- Multi-Categorical Approaches - Ordered Progress Variable (0-9)	Binary Discrete*
International Scope (Partner Origin)	Geographical scope of collaboration	Binarys

* truncated variable (left censored at zero)

Table 103: Overview of Data Sources

Data Type	**Primary Data Sources**	**Secondary Data Sources**
Sample-Firm Identification	BioCentury BioScan BioVenture Ernst&Young Reports Recombinant Capital	National Industry Associations Stock Exchanges Classifications
Event Announcements	Lexis Nexis Database	Faktiva Database National News Services Recombinant Capital
Stock Prices / Indices	Datastream	Reuters
Company Financial Data	Datastream	Reuters Company Annual Reports
Other	European Patent Database Recombinant Capital	Industry Reports Company Websites

Event Study Methodology

Equations for Calculation of Stock Returns

(23) $$R_{i,t} = \frac{P_{i,t} + D_{i,t} - P_{i,t-1}}{P_{i,t-1}}$$

(24) $$R_{i,t} = \log\left[\frac{(P_{i,t} + D_{i,t})}{P_{i,t-1}}\right]$$

with: $P_{i,t}$ = Price of Security i on day t

$P_{i,t-1}$ = Price of Security i on day t-1

$D_{i,t}$ = Dividend paid on day t

Table 104: Discussion of Return Models not used in Present Study

(a) Mean-Adjusted Return Model
The mean-adjusted approach assumes that the expected return of a given security is constant across time. Consequently, the expected return on that security equals the average (mean) return it has yielded over a relevant estimation period.[569] While simple to implement, the mean-adjusted return model has been proven ineffective in determining expected returns in an event-study context. While early studies, e.g., (Brown and Warner 1985), found it to yield results similar to those of more sophisticated estimation techniques, (Cable and Holland 1999) provide evidence of it being invalid (i.e., lacking explanatory power) and clearly inferior to models incorporating market developments during the event period. Moreover, (Klein and Rosenfeld 1987) find mean-adjusted expected returns systematically biased in market environments exhibiting persistent value increases (bullish) or decreases (bearish). Little surprisingly, only one of the event studies [Ravichandran/Sa-Aadu (1988)] in the domain of corporate collaboration has used a mean-adjusted return model.

569 The Equations presented in this section are similarly presented in the various review articles [e.g., (Armitage 1995), (MacKinlay 1997), (Strong 1992)]. In order to avoid confusion, the variables and subscripts are utilized consistently and independent of any one source.

(b) Economic Models

Economic models are statistical representations of asset-pricing theories. In particular, the Capial Asset Pricing Model (CAPM) has been used extensively in early event studies. Similarly, some work has included models based on the Arbitrage Pricing Theory (APT).[570] (Armitage 1995) reviews evidence indicating substantial differences in the results (i.e., predictions) of CAPM and the standard market model. While only (Cable and Holland 1999) outright suggest that CAPM is inferior, the overall lack of empirical validation of CAPM [cf. Fama/French (1996)] and the greater risk of size-based biases [cf. Dimson/March (1986)] limit its appeal. Not surprisingly, only one study has applied either in the context of alliance-related events [CAPM by Sleuwaegen et al. (2003), the Fama-French Three-Factor Model by (Subramaniana et al. 2006)]. Similarly, the gains in explanatory power derived from APT have been shown to be negligible [cf. Brown/Weinstein (1985)].

Equations for Averaging, Cumulating, and Standardization of Abnormal Returns:

- Average Abnormal Returns (AAR) for N events on day t

(25)
$$AAR_{N,t} = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t}$$

- Cumulative Abnormal Returns (CAR) for event i over T days

(26)
$$CAR_{i,T} = \sum_{t=t_1}^{t_2} AR_{i,t}$$

- Cumulative Average Abnormal Returns (CAAR) for N events over T days

(27)
$$CAAR_{N,T} = \sum_{t=t_1}^{t_2} AAR_{N,t}$$
$$CAAR_{N,T} = \frac{1}{N}\sum_{i=1}^{N} CAR_{i,T}$$

570 See (MacKinlay 1997). (Armitage 1995) also addresses event-studies using the Fama/MacBeth (1973) model.

- Standardized Abnormal Returns (SAR) for event i on day t

(28) $$SAR_{i\,t} = \frac{AR_{i\,t}}{SD_{i\,t}}$$

- Standardized Average Abnormal Returns (SAAR) for N events on day t

(29) $$SAAR_{N\,t} = \frac{1}{N}\sum_{i-1}^{N} SAR_{i\,t}$$

- Standardized Cumulative Abnormal Returns (SCAR) for event i over T days

(30) $$SCAR_{i\,T} = \frac{1}{\sqrt{T}}\sum_{t=t_1}^{t_2} SAR_{i\,t}$$

- Standardized Average Abnormal Returns (SCAAR) for N events over T days

(31) $$SCAAR_{N\,T} = \frac{1}{\sqrt{T}}\sum_{t=t_1}^{t_2} SAAR_{N\,t}$$

$$SCAAR_{N\,T} = \frac{1}{N}\sum_{i-1}^{N} SCAR_{i\,T}$$

$$SCAAR_{N\,T} = \frac{1}{N} \times \frac{\sum_{i=1}^{N} SCAR_{i\,T}}{\left(\frac{L-2}{L-4}\right)^{0.5}}$$

Table 105: Discussion of AR Significance Tests not Used in Present Study

(a) Student t-Test
Standard t-.tests may be performed on either daily or cumulated abnormal returns. It effectively tests the magnitude of the observations relative to their cross-sectional variation. The same test statistic may be constructed for a multi-day event-window. While similar for daily abnormal returns, this approach differs from the above cross-sectional standardization for CARs. Specifically, t-tests rely on the cross-sectional variation of CARs, whereas standardization of individual ARs utilizes the daily cross-sectional variation. Consequently, t-tests may be relatively crude measures, if cumulating leads to a reduction in variance. Nonetheless, the a majority of prior alliance-related event studies employs t-tests either by themselves or in connection with other significance tests. The present study abstains from doing so in favor of more advanced tests. In particular, the cross-sectional variation underlying the t-test is considered as part of the cross-sectionally standardized test.

(b) Z-Test and Share-Specific Methods
In the most general event-study-specific framework, the standard error of estimation may provide a suitable measure of variation. That is, the variance and standard deviation generated by the market model (or alternative regression-based return generating process) is used to construct test statistics or to standardize daily abnormal returns. (MacKinlay 1997) outlines the testing procedure based on cumulating and averaging (unstandardized) abnormal returns as well as the variance terms. (Campbell et al. 1997) extend both approaches.[571] The standardization approach goes back to (Brown and Warner 1980) and has been used for daily data by Dyckman et al. (1984). (Armitage 1995) refers to this approach as the 'share time series' method. While these two basic approaches have exclusively relied on the cross-sectional variation during the event period and the security-specific variation during the estimation period, respectively. While the former thus has considered the actual variation of abnormal returns, the latter has expanded the testing perspective to include the estimation period. The commonly used (Brown and Warner 1985) and (Dodd and Warner 1983) Z-tests incorporate elements of both.

571 (MacKinlay 1997) and (Campbell et al. 1997) describe that the security's estimation error may need to be expanded due to sampling error for shorter estimation periods. Given sufficiently large estimation windows, however, such sampling errors converge to zero.

(c) (Boehmer et al. 1991) Test

If the variation of abnormal returns in the event period is systematically higher than the variation in the estimation period, tests incorporating only information from the estimation period (e.g., share-specific methods and the Brown-Warner procedure) will be too often reject the null hypothesis of ARs being zero (type-1 error). Cross-sectional methods (such as standard t-tests, and the cross-sectionally standardized test employed in this study) account for this bias, but fail to consider systematic differences in the volatility of individual stocks [cf. (Armitage 1995)].

(Boehmer et al. 1991) propose a test explicitly correcting for such event-induced increases in variance. It effectively builds on the Dodd-Warner-type SAAR and corrects them for their standard deviation (i.e., the SD of SAR on a given day). Since the first standardization was performed using a longitudinal measure of variance, the (remaining) cross-sectional variation of SAR reflects the difference in volatility between estimation and event periods.

In spite of its advantages, the Boehmer test has only been applied once in an alliance-related context. (Bayona et al. 2002b, 2002a) use it in a study primarily focusing on the information content of alliance formation announcements. Furthermore, the test remains susceptible to cross-correlation among abnormal returns (e.g., due to event clustering).[572] In the present study, it is not used, since the components included in it are tested using the four separate test statistics, which allows to more clearly identify the relevan sources of variation in ARs.

(d) Non-parametric Sign and Signed-Rank Tests

Given that abnormal returns may be non-normally distributed, the positive or negative sign of abnormal returns may be regarded as a basic indicator for value impact. The sign and signed-rank tests represent relatively smple approaches based on the frequency of positive and negative ARs upon event announcement.

Similarly, many studies report the frequency of positive and negative observations without explicitly conducting sign tests. Some authors, such as McConnel/Nantell (1985), Koh/Ventakaram (1991), Madhavan/Prescott (1995) or Houston (2003), also use non-parametric Wilcoxon test statistics in light of not normally distributed ARs. (Brooke and Oliver 2004) use the Kruskall-Wallis test.

The present study relies on the more elaborate Corrado test to ensure robustness of test results against non-normality.

[572] See section 4.3.3 for a discussion regarding the underlying assumption of independent abnormal return observations.

Time Series Methodology

Table 106: Overview of Return Time Series and Normality Tests

Company	N	Mean	Standard Deviation	Skewness		Kurtosis		Shapiro-Wilks
acambis	1898	0.0009	0.0366	2.2464	***	33.6650	***	***
actelion	937	0.0019	0.0466	3.3765	***	138.4602	***	***
active	1998	0.0011	0.0382	0.4004	***	19.3964	***	***
alizyme	1720	0.0017	0.0473	3.6456	***	44.0907	***	***
antisoma	1014	0.0006	0.0590	9.3239	***	196.6124	***	***
bavarian	1167	0.0009	0.0432	2.4148	***	37.7447	***	***
berna	633	-0.0010	0.0352	0.7276	***	11.6763	***	***
cambridge	1651	0.0008	0.0400	2.9153	***	37.1651	***	***
celltech	2020	0.0003	0.0320	-1.6174	***	28.0434	***	***
cenes	1270	-0.0015	0.0501	1.6998	***	26.5708	***	***
cerep	1473	0.0011	0.0482	2.5872	***	31.1896	***	***
crucell	806	-0.0008	0.0407	0.9107	***	10.3040	***	***
cytos	266	0.0005	0.0518	0.4171	***	5.9251	***	***
decode	867	0.0003	0.0574	1.5319	***	12.6452	***	***
evotec	1049	0.0018	0.0665	2.6780	***	25.2884	***	***
genmab	797	-0.0011	0.0392	-4.3094	***	79.2201	***	***
gpc	909	0.0004	0.0575	1.1091	***	7.2678	***	***
innogenetics	267	0.0012	0.0273	0.6175	***	4.8739	***	***
isotis	885	-0.0010	0.0495	1.3240	***	11.4416	***	***
karo	1636	-0.0003	0.0366	0.6236	***	8.0953	***	***
ks	1426	-0.0007	0.0355	2.0199	***	54.9434	***	***
lion	857	-0.0012	0.0625	1.5233	***	9.7455	***	***
medigene	887	0.0000	0.0686	2.0309	***	15.1124	***	***
mologen	1319	0.0007	0.0593	0.6658	***	6.5314	***	***
morphpsys	1219	0.0020	0.0779	3.8428	***	37.8279	***	***
neurosearch	1885	0.0007	0.0385	-1.0703	***	51.2711	***	***
nicox	1055	0.0012	0.0512	-3.4087	***	70.7600	***	***
november	940	0.0013	0.0778	7.6492	***	134.5876	***	***
novuspharma	791	-0.0015	0.0301	0.8408	***	9.5704	***	***
oxfordglyco	1255	0.0004	0.0392	0.8747	***	14.6380	***	***
pharmagene	697	-0.0011	0.0381	-1.6496	***	41.3635	***	***

Table 106 (Continued)

Company	N	Mean	Standard Deviation	Skewness		Kurtosis		Shapiro-Wilks
pharming	1153	0.0016	0.0832	3.9874	***	65.9425	***	***
phytopharm	1842	0.0007	0.0364	1.8731	***	25.7879	***	***
powderject	1531	0.0012	0.0319	6.2001	***	118.5558	***	***
ppl	1458	-0.0022	0.0420	3.4212	***	42.8000	***	***
proterics	2019	0.0005	0.0408	1.8638	***	18.5494	***	***
provalis	1523	-0.0002	0.0601	2.0560	***	26.0157	***	***
pyro	876	-0.0016	0.0410	0.3989	***	4.8325	***	***
qiagen	1791	0.0015	0.0387	0.0241		9.6243	***	***
serono	2010	0.0011	0.0268	0.4012	***	8.4738	***	***
shire	1946	0.0010	0.0301	-0.3267	***	20.0269	***	***
skye	1964	0.0006	0.0351	0.9260	***	11.9375	***	***
transgene	1453	-0.0001	0.0514	1.3233	***	10.2308	***	***
vernalis	2021	-0.0008	0.0469	0.1406	***	12.2518	***	***
weston	704	-0.0027	0.0704	3.3976	***	135.6699	***	***
xenova	1714	-0.0003	0.0551	2.4500	***	46.2699	***	***
stoxx	2087	0,0003	0,0125		**		***	***
ch	2087	0,0004	0,0139				***	***
sw	2087	0,0003	0,0121		**		***	***
uk	2087	0,0004	0,0132		***		***	***
dk	2086	0,0005	0,0182		***		***	***
fr	2087	0,0003	0,0134				***	***
de	2087	0,0004	0,0147		*		***	***
nl	2087	0,0002	0,0108				***	***
us	2087	0,0004	0,0105				***	***
be	2087	0,0004	0,0141		***		***	***
it	2087	0,0004	0,0171		***		***	***
estoxx	2087	0,0003	0,0162				***	***
stoxxxeu	2087	0,0004	0,0122		*		***	***
stoxxpbtm	2087	0,0003	0,0123				***	***
stoxxbttm	2087	0,0004	0,0130		***		***	***
tech	2087	0,0002	0,0189				***	***
btindex	2066	0,0006	0,0146		***		***	***

Source: Own Analysis

Table 107: Overview of Indices Used in Logitudinal Analysis

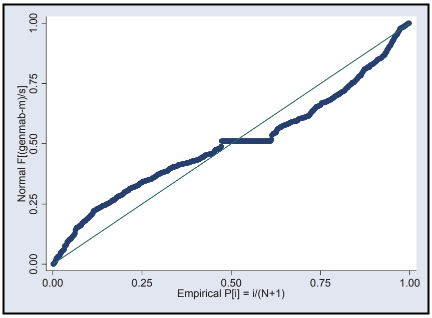
Variable	Name	Description
stoxx	Stoxx 600	600 largest European companies
estoxx	Eurostoxx	Stoxx 600 companies from Eurozone
stoxxxeu	Stoxx X Eurozone	Stoxx 600 companies from outside Eurozone
stoxxpbtm	Stoxx Pharma/Biotech	Stoxx 600 companies in Pharmaceutical and Biotech Industries
stoxxbttm	Stoxx Biotech Total Market	Stoxx 600 companies in Biotechnology Industry
tech	High Technology Index	Equally-weighted average return of the three main European high technology indices (Techmark, Nexteconomy, and Nemax/Tecdax)
btindex	Intra-Sample Index (also referred to as DBF index)	Average return on equal-weighted portfolio of the 46 companies included in present study's final sample
Local	Appropriate home-country index for focal firm from following list[573]:	
- be	BEL 20	20 largest Belgian companies
- ch	Swiss Market	All companies listed in Switzerland
- de	DAX 30	30 largest German companies
- dk	OMX	Leading Danish companies
- fr	SBF 120	120 largest French companies
- it	Milan Comit Global	Leading Italian companies (Milan stock exchange only)
- nl	AEX	Leading Dutch companies (Amsterdam stock exchange only)
- no	Oslo SE OBX	Leading Norwegian companies (Oslo stock exchange only)
- sw	Affarsvarlden General	Leading Swedish companies
- uk	FTSE Total Market	All companies listed in UK (London stock exchange only)
- us	S&P 500	500 largest U.S. companies

Source: Own Compilation

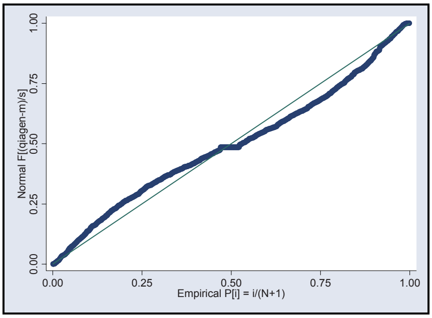
573 The choice of index for each country was based on the suggested home country index directory of Datastream™

Figure 59: Selected Normal Plots Indicating Non-Normality

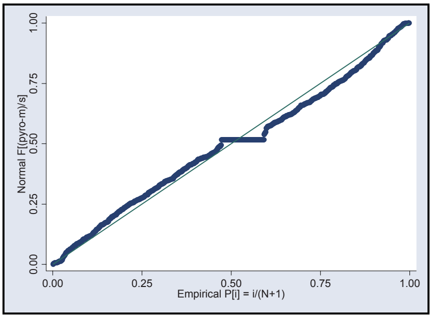
(a) Genmab
(Largest negative Skewness)



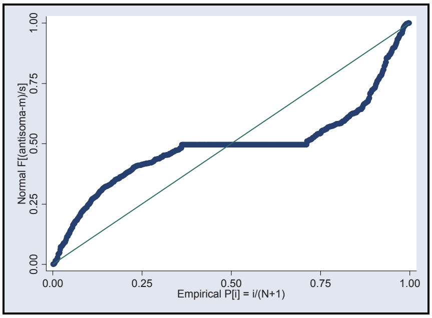
(b) Qiagen
(Only insignificant Skewness)



(c) PyroSequencing
(Smallest Kurtosis)



(d) Antisoma
(Largest Skewness and Kurtosis)



Source: Own Analysis

Table 108: Results of Durbin-Watson and Runs Tests for Autocorrelation

Company	N	Durbin Watson Test II		Durbin Watson Test II		Runs Test	
		d Stat	Z-Score	d Stat	Z-Score	Z-Score	
acambis	1898	1,2566	16,1944	1,2674	15,9586	-10,8704	***
actelion	937	1,2152	12,0116	1,2317	11,7597	1,0931	
active	1998	1,5481	10,0991	1,5720	9,5652	1,4864	
alizyme	1720	1,1851	16,8971	1,1987	16,6152	-9,9089	***
antisoma	1014	1,1376	13,7302	1,1433	13,6401	-6,1940	***
bavarian	1167	1,5075	8,4121	1,5219	8,1663	0,0525	
berna	633	1,5390	5,7996	1,5848	5,2229	-0,6107	
cambridge	1651	1,0565	19,1688	1,1016	18,2512	-8,7926	***
celltech	2020	1,4401	12,5820	1,4770	11,7539	-7,3470	***
cenes	1270	1,3970	10,7440	1,4231	10,2792	-5,6201	***
cerep	1473	1,5117	9,3697	1,5385	8,8558	-3,9940	***
crucell	806	1,6419	5,0834	1,6424	5,0765	-0,5219	
cytos	266	1,4429	4,5427	1,4687	4,3328	1,2723	
decode	867	1,4912	7,4915	1,5537	6,5711	-0,1862	
evotec	1049	1,3793	10,0521	1,3972	9,7623	0,3398	
genmab	797	1,5691	6,0822	1,5653	6,1354	-1,1497	
gpc	909	1,7081	4,4008	1,6793	4,8340	1,2943	
innogenetics	267	1,5112	3,9933	1,5904	3,3462	1,0077	
isotis	885	1,6802	4,7563	1,7121	4,2829	1,3454	
karo	1636	1,6473	7,1332	1,6539	7,0000	-11,8373	***
ks	1426	1,5170	9,1205	1,5550	8,4025	0,9987	
lion	857	1,4350	8,2702	1,3826	9,0368	-0,0341	
medigene	887	1,4986	7,4662	1,4720	7,8633	2,9229	***
mologen	1319	1,6433	6,4780	1,6690	6,0101	1,9059	*
morphpsys	1219	1,3472	11,3962	1,2942	12,3206	-0,7163	
neurosearch	1885	1,5158	10,5117	1,5047	10,7517	-1,7438	*
nicox	1055	1,4044	9,6727	1,4103	9,5775	-0,8611	
november	940	1,3315	10,2483	1,3358	10,1827	0,0654	
novuspharma	791	1,4869	7,2153	1,5020	7,0034	-1,1029	
oxfordglyco	1255	1,2465	13,3470	1,2711	12,9110	-10,3549	***
pharmagene	697	1,1315	11,4649	1,1455	11,2795	-8,4808	***
pharming	1153	1,3694	10,7058	1,3545	10,9599	0,3006	
phytopharm	1842	1,2874	15,2917	1,2936	15,1587	-11,7753	***

Table 108 (Continued)

Company	N	Durbin Watson Test II		Durbin Watson Test II		Runs Test	
		d Stat	Z-Score	d Stat	Z-Score	Z-Score	
powderject	1531	1,2317	15,0305	1,2305	15,0547	-10,0723	***
ppl	1458	1,3080	13,2107	1,3057	13,2565	-8,5122	***
proterics	2019	1,3705	14,1423	1,3729	14,0893	-7,9019	***
provalis	1523	1,5593	8,5984	1,5638	8,5116	-6,2559	***
pyro	876	1,4842	7,6335	1,5180	7,1325	-0,5615	
qiagen	1791	1,4916	10,7578	1,4994	10,5923	-1,6896	*
serono	2010	1,5569	9,9325	1,5968	9,0374	-0,4341	
shire	1946	1,4647	11,8077	1,4385	12,3850	-6,0155	***
skye	1964	1,2626	16,3397	1,2873	15,7930	-8,2531	***
transgene	1453	1,5325	8,9102	1,5265	9,0236	-0,6561	
vernalis	2021	1,6309	8,2956	1,6261	8,4051	-0,9443	
weston	704	1,4225	7,6608	1,4334	7,5165	-4,9489	***
xenova	1714	1,4143	12,1243	1,4232	11,9392	-7,9629	***
stoxx	2087	1,5883	9,4031			-1,8173	*
ch	2087	1,5724	9,7663	1,7490	5,733188	-1,7297	*
sw	2087	1,6228	8,6163	1,7089	6,648705	-1,2918	
uk	2087	1,5377	10,5587	1,4811	11,85178	-0,3722	
dk	2086	1,4972	11,4848	1,5007	11,40488	-1,3258	
fr	2087	1,5292	10,7540	1,5989	9,162493	-0,4160	
de	2087	1,5898	9,3706	1,7087	6,654684	-4,6636	***
nl	2087	1,5819	9,5510	1,6272	8,516157	-0,9415	
us	2087	1,5231	10,8913	1,5942	9,26641	-3,7668	***
be	2087	1,5744	9,7222	1,6221	8,631681	-0,7663	
it	2087	1,6247	8,5726	2,0219	-0,5006599	0,8539	
estoxx	2087	1,5542	10,1832	1,6540	7,902535	-0,5912	
stoxxxeu	2087	1,6480	8,0402	2,0025	-0,057253	0,1125	
stoxxpbtm	2087	1,3562	14,7054	1,3767	14,23778	-3,3061	***
stoxxbttm	2087	1,3756	14,2622	1,7360	6,030813	-4,2257	***
tech	2087	1,3843	14,0636	1,3709	14,36928	-5,9335	***
btindex	2066	1,2217	17,6887	1,1912	18,38235	-7,3060	***

Source: Own Analysis

Table 109: Background on Stationarity

Non-Stationary Processes
The distinction of stationary and non-stationary data is reflected in the processes describing them. Non-stationary processes may be of two types: On one hand, non-stationarity may arise out of the fact that they are additive in nature. That is, the stationary 'white noise' is added to the variables ex-ante value, leading to the observed values following a non-deterministic drift (random walk). On the other hand, non-stationarity may be deterministic in that it follows a linear trend (possibly with a 'white noise' disturbance term). In this case, the non-stationarity results directly from the time-depending trend. For empirical purposes, trend non-stationarity is of limited importance in finance and economics applications [cf. Brooks (2002)]. Contrarily, random walk processes (i.e. drift non-stationarity), however, are fairly common phenomena and have to be tested an accounted for. For instance, stock prices are by definition drift processes, since their value in one time period enters fully into the subsequent value. Drift non-stationarity requires data series to be differenced prior to applying further analyses, i.e. the persistence effect has to be eliminated. Since most event studies use data on stock returns, i.e. differences in stock prices (often adjusted for dividend payments and other value-related effects), drift non-stationarity rarely is a concern in this context. Constant mean and variance ensure that inferences based on a given time interval may be extrapolated to other time periods. Contrarily, autocovariance may still reduce the validity of extrapolation, but constancy in this domain allows for the use of relatively simple models, e.g., Box/Jenkins (1976)-type ARMA models. In the extreme, a stationary process may be 'white noise', i.e., possessing zero autocorrelation in addition to constant mean and variance.

Table 110: Results of Augmented Dickey-Fuller Test for Stationarity

Company	N	ADF Statistic		Critial Value[574]		
				1%	5%	10%
acambis	1898	-35,1648	***	-3,430	-2,860	-2,570
actelion	937	-29,8132	***	-3,430	-2,860	-2,570
active	1998	-38,2759	***	-3,430	-2,860	-2,570
alizyme	1720	-29,3643	***	-3,430	-2,860	-2,570
antisoma	1014	-37,7030	***	-3,430	-2,860	-2,570
bavarian	1167	-35,1890	***	-3,430	-2,860	-2,570
berna	633	-20,1663	***	-3,440	-2,870	-2,570
cambridge	1651	-27,0620	***	-3,430	-2,860	-2,570
celltech	2020	-34,3882	***	-3,430	-2,860	-2,570
cenes	1270	-27,5379	***	-3,430	-2,860	-2,570
cerep	1473	-34,8989	***	-3,430	-2,860	-2,570
crucell	806	-25,6084	***	-3,430	-2,860	-2,570
cytos	266	-12,9131	***	-3,479	-2,884	-2,574
decode	867	-23,0492	***	-3,430	-2,860	-2,570
evotec	1049	-28,9936	***	-3,430	-2,860	-2,570
genmab	797	-23,6688	***	-3,430	-2,860	-2,570
gpc	909	-29,6456	***	-3,430	-2,860	-2,570
innogenetics	267	-13,6063	***	-3,474	-2,883	-2,573
isotis	885	-28,7727	***	-3,430	-2,860	-2,570
karo	1636	-32,7501	***	-3,430	-2,860	-2,570
ks	1426	-32,9934	***	-3,430	-2,860	-2,570
lion	857	-26,4168	***	-3,430	-2,860	-2,570
medigene	887	-26,9663	***	-3,430	-2,860	-2,570
mologen	1319	-35,4347	***	-3,430	-2,860	-2,570
morphpsys	1219	-41,1642	***	-3,430	-2,860	-2,570
neurosearch	1885	-33,8325	***	-3,430	-2,860	-2,570
nicox	1055	-34,9075	***	-3,430	-2,860	-2,570
november	940	-38,8972	***	-3,430	-2,860	-2,570

574 This statistic follows a χ^2 distribution with degrees of freedom equal to the number of lags included in the second regression. Consequently, the critical value (for significance) may vary with sample size. However, only in three cases, the critical value differs from the asymtotic one.

Table 110 (Continued)

Company	N	ADF Statistic		Critial Value[575]		
				1%	5%	10%
novuspharma	791	-25,3434	***	-3,430	-2,860	-2,570
oxfordglyco	1255	-25,9505	***	-3,430	-2,860	-2,570
pharmagene	697	-15,8439	***	-3,430	-2,860	-2,570
pharming	1153	-29,3179	***	-3,430	-2,860	-2,570
phytopharm	1842	-30,8279	***	-3,430	-2,860	-2,570
powderject	1531	-36,4262	***	-3,430	-2,860	-2,570
ppl	1458	-31,8245	***	-3,430	-2,860	-2,570
proterics	2019	-35,7670	***	-3,430	-2,860	-2,570
provalis	1523	-33,2489	***	-3,430	-2,860	-2,570
pyro	876	-23,6245	***	-3,430	-2,860	-2,570
qiagen	1791	-36,1493	***	-3,430	-2,860	-2,570
serono	2010	-38,6009	***	-3,430	-2,860	-2,570
shire	1946	-36,3428	***	-3,430	-2,860	-2,570
skye	1964	-32,1687	***	-3,430	-2,860	-2,570
transgene	1453	-32,6278	***	-3,430	-2,860	-2,570
vernalis	2021	-41,5586	***	-3,430	-2,860	-2,570
weston	704	-18,8904	***	-3,430	-2,860	-2,570
xenova	1714	-30,1968	***	-3,430	-2,860	-2,570

575 This statistic follows a χ^2 distribution with degrees of freedom equal to the number of lags included in the second regression. Consequently, the critical value (for significance) may vary with sample size. However, only in three cases, the critical value differs from the asymtotic one.

Table 110 (Continued)

Index	N	ADF Statistic	Critial Value[576]		
			1%	5%	10%
stoxx	2087	-42,0054 ***	-3,430	-2,860	-2,570
ch	2087	-41,9499 ***	-3,430	-2,860	-2,570
sw	2087	-42,4345 ***	-3,430	-2,860	-2,570
uk	2087	-40,0814 ***	-3,430	-2,860	-2,570
dk	2086	-37,9506 ***	-3,430	-2,860	-2,570
fr	2087	-40,8316 ***	-3,430	-2,860	-2,570
de	2087	-42,1532 ***	-3,430	-2,860	-2,570
nl	2087	-41,2751 ***	-3,430	-2,860	-2,570
us	2087	-40,4988 ***	-3,430	-2,860	-2,570
be	2087	-41,1780 ***	-3,430	-2,860	-2,570
It	2087	-43,3201 ***	-3,430	-2,860	-2,570
estoxx	2087	-42,4314 ***	-3,430	-2,860	-2,570
stoxxxeu	2087	-42,8280 ***	-3,430	-2,860	-2,570
stoxxpbtm	2087	-36,0386 ***	-3,430	-2,860	-2,570
stoxxbttm	2087	-37,3823 ***	-3,430	-2,860	-2,570
tech	2087	-35,1805 ***	-3,430	-2,860	-2,570
btindex	2066	-33,0964 ***	-3,430	-2,860	-2,570

Source: Own Analysis

[576] This statistic follows a χ^2 distribution with degrees of freedom equal to the number of lags included in the second regression. Consequently, the critical value (for significance) may vary with sample size. However, only in three cases, the critical value differs from the asymtotic one.

Table 111: Lagrange-Multiplier Tests of ARCH Properties

Company	N	Time Series		Market Model		Double-lagged	
		Chi^2	p-Value	Chi^2	p-Value	Chi^2	p-Value
acambis	1898	28,87	0,0000	29,57	0,0000	24,80	0,0000
actelion	937	0,00	0,9745	0,00	0,9956	28,93	0,0000
active	1998	18,03	0,0000	10,72	0,0011	6,04	0,0140
alizyme	1720	189,58	0,0000	178,14	0,0000	19,47	0,0000
antisoma	1014	0,04	0,8424	0,06	0,8125	0,14	0,7128
bavarian	1167	1,25	0,2642	1,41	0,2346	0,93	0,3356
berna	633	0,88	0,3487	0,03	0,8624	0,12	0,7268
cambridge	1651	19,95	0,0000	15,86	0,0001	9,42	0,0022
celltech	2020	2,00	0,1576	1,12	0,2911	0,32	0,5715
cenes	1270	0,87	0,3500	0,75	0,3856	1,83	0,1761
cerep	1473	23,19	0,0000	20,06	0,0000	7,48	0,0063
crucell	806	1,89	0,1694	1,74	0,1877	0,96	0,3272
cytos	266	5,45	0,0195	5,28	0,0216	5,50	0,0190
decode	867	3,51	0,0609	2,52	0,1127	3,83	0,0504
evotec	1049	26,39	0,0000	43,92	0,0000	37,86	0,0000
genmab	797	0,02	0,8808	0,07	0,7914	0,03	0,8532
gpc	909	13,30	0,0003	26,14	0,0000	19,07	0,0000
innogenetics	267	9,00	0,0027	14,40	0,0001	1,98	0,1594
isotis	885	2,09	0,1484	2,35	0,1257	1,97	0,1606
karo	1636	2,41	0,1208	2,38	0,1231	2,12	0,1455
ks	1426	43,41	0,0000	42,21	0,0000	24,22	0,0000
lion	857	1,84	0,1745	1,34	0,2473	0,26	0,6124
medigene	887	15,09	0,0001	17,17	0,0000	12,50	0,0004
mologen	1319	46,88	0,0000	47,01	0,0000	16,71	0,0000
morphpsys	1219	13,23	0,0003	11,26	0,0008	10,88	0,0010
neurosearch	1885	2,45	0,1178	1,70	0,1922	17,01	0,0000
nicox	1055	5,18	0,0228	4,85	0,0276	24,67	0,0000
november	940	0,21	0,6504	0,00	0,9744	0,00	0,9570
novuspharma	791	39,56	0,0000	40,37	0,0000	36,50	0,0000
oxfordglyco	1255	32,06	0,0000	38,12	0,0000	37,29	0,0000
pharmagene	697	4,92	0,0266	4,35	0,0369	2,89	0,0893
pharming	1153	12,06	0,0005	15,93	0,0001	11,87	0,0006

Table 111 (Continued)

Company	N	Time Series		Market Model		Double-lagged	
		Chi²	p-Value	Chi²	p-Value	Chi²	p-Value
phytopharm	1842	24,13	0,0000	23,29	0,0000	3,61	0,0574
powderject	1531	0,12	0,7341	0,13	0,7158	0,05	0,8234
ppl	1458	7,21	0,0072	6,75	0,0094	4,22	0,0400
proterics	2019	189,80	0,0000	189,98	0,0000	57,33	0,0000
provalis	1523	29,88	0,0000	31,39	0,0000	25,36	0,0000
pyro	876	5,64	0,0176	9,22	0,0024	1,91	0,1670
qiagen	1791	9,79	0,0018	15,96	0,0001	16,30	0,0001
serono	2010	38,70	0,0000	47,18	0,0000	58,72	0,0000
shire	1946	108,51	0,0000	88,28	0,0000	83,50	0,0000
skye	1964	20,72	0,0000	17,00	0,0000	20,30	0,0000
transgene	1453	97,40	0,0000	77,88	0,0000	98,18	0,0000
vernalis	2021	36,54	0,0000	30,27	0,0000	12,61	0,0004
weston	704	12,91	0,0003	13,64	0,0002	33,61	0,0000
xenova	1714	0,47	0,4940	0,34	0,5597	0,75	0,3859
stoxx	2087	45,62	0,0000	N/A			
ch	2087	54,39	0,0000	79,44	0,0000	19,04	0,0000
sw	2087	50,27	0,0000	75,02	0,0000	61,46	0,0000
uk	2087	62,00	0,0000	31,73	0,0000	35,02	0,0000
dk	2086	142,01	0,0000	71,91	0,0000	54,18	0,0000
fr	2087	43,42	0,0000	4,81	0,0283	4,87	0,0274
de	2087	75,21	0,0000	174,93	0,0000	262,74	0,0000
nl	2087	96,23	0,0000	68,75	0,0000	2,88	0,0898
us	2087	60,20	0,0000	149,11	0,0000	129,60	0,0000
be	2087	191,66	0,0000	336,93	0,0000	232,55	0,0000
it	2087	124,39	0,0000	53,94	0,0000	34,45	0,0000
estoxx	2087	48,69	0,0000	13,06	0,0003	7,90	0,0050
stoxxxeu	2087	41,56	0,0000	81,19	0,0000	25,48	0,0000
stoxxpbtm	2087	62,49	0,0000	9,05	0,0026	3,50	0,0613
stoxxbttm	2087	36,36	0,0000	24,25	0,0000	23,43	0,0000
tech	2087	48,92	0,0000	57,95	0,0000	38,16	0,0000
btindex	2066	40,16	0,0000	19,16	0,0000	8,14	0,0043

Source: Own Analysis

Table 112: Event-Study Benchmarks Used in Prior European Event Studies

Reference	Object of Study	Benchmark
(Andres et al. 2004)	LBOs	Dow-Jones STOXX 600 index
(Campa and Hernando 2004)	Acquisitions	Local (country-specific) value-weighted market indices
(Dutordoir and Van de Gucht 2006)	Convertible Debt Issuence	
(Grölund et al. 2004)	Sale-and-Leaseback Agreements	(Unspecified) European Market Portfolio
(Martynova and Renneboog 2006)	Acquisitions	MSCI-Europe Index
(Veld and Veld-Merkoulova 2004)	Spin-Offs	Local (country-specific) datastream total return indices

Source: Own Compilation

Table 113: Alternative Indices for Capturing Specific Return Drivers

Categories	Country Effects	Size Effects	Industry Effects
Available	(a) National Market Indices (b) Selective National Indices	(a) Small-Firm Indices (b) Zero-Investment Portfolios (c) New Market Index	(a) Pharma-Healthcare Index (b) Biotechnology Index (c) Intra-Sample Index
Used in Present Study	Selective National Indices	Aggregate New Market Index	Pharmaceutical Index Biotechnology Index Intra-Sample Index

Source: Own Illustration

Table 114: Correlations of Daily Index Returns

Correlations	stoxx	estoxx	stoxxxeu	stoxxpbtm	stoxxbttm	tech	btindex
stoxx	1						
estoxx	0.9720	1					
stoxxxeu	0.9631	0.8748	1				
stoxxpbtm	0.7522	0.6793	0.7864	1			
stoxxbttm	0.6026	0.5670	0.6023	0.4884	1		
tech	0.7299	0.7319	0.6766	0.4220	0.5974	1	
btindex	0.5591	0.5589	0.5208	0.3464	0.6088	0.6831	1

Table 114 (Continued)

Correlations	uk	de	ch	fr	nl	be	sw	dk	us
uk	1								
de	0.7272	1							
ch	0.7465	0.7258	1						
fr	0.8199	0.8047	0.7727	1					
nl	0.8083	0.7926	0.7932	0.8598	1				
be	0.6727	0.6618	0.7092	0.7156	0.7727	1			
sw	0.7187	0.6956	0.6589	0.7740	0.7262	0.5703	1		
dk	0.5880	0.5687	0.5765	0.6157	0.6204	0.5349	0.5993	1	
us	0.4179	0.5016	0.4038	0.4520	0.4295	0.4054	0.3964	0.2756	1

Correlations	stoxx	estoxx	stoxxxeu	stoxxpbtm	stoxxbttm	tech	Btindex
ch	0,8422	0,8129	0,8205	0,7750	0,4734	0,5390	0,4284
sw	0,8146	0,8083	0,7671	0,5468	0,5180	0,7054	0,5484
uk	0,9113	0,8447	0,9262	0,7084	0,5702	0,6895	0,5265
dk	0,6582	0,6527	0,6209	0,4642	0,4439	0,5446	0,4958
fr	0,9264	0,9505	0,8362	0,6520	0,5402	0,6985	0,5309
de	0,8586	0,8936	0,7631	0,6136	0,4926	0,6654	0,4791
nl	0,9051	0,9124	0,8375	0,6619	0,5140	0,6404	0,5003
us	0,4738	0,4798	0,4376	0,3684	0,2426	0,3761	0,2365
be	0,7447	0,7482	0,6928	0,6158	0,4038	0,4665	0,3669
it	0,6863	0,7086	0,6133	0,4410	0,4585	0,5976	0,5115
no	0,6557	0,6445	0,6241	0,4643	0,4644	0,5578	0,4837

All correlations significant at 1% level
Source: Own Analysis

Table 115: Correlations of R2 Statistics by Model Specification

Correlations	stoxx	Local	ezone	pbtm	bttm	tech	btindex
stoxx	1						
local	0.9627	1					
ezone	0.9950	0.9588	1				
pbtm	0.9188	0.8823	0.8974	1			
bttm	0.7870	0.7153	0.7536	0.7434	1		
tech	0.9238	0.8779	0.9392	0.7486	0.6866	1	
btindex	0.6960	0.6686	0.7159	0.4835	0.6075	0.8041	1

All correlations significant at 1% level
Source: Own Analysis

Table 116: Significance of Wilcoxon Paired-Rank Test on R2 Statistics

	stoxx	Local	ezone	pbtm	bttm	tech	btindex
Mean	0.0506	0.0519	0.0490	0.0227	0.0670	0.0725	0.1173
Median	0.0365	0.0358	0.0316	0.0159	0.0432	0.0494	0.1111
Stoxx600 (stoxx)	|	|	|	|	|	|	|
Local Indices (local)	n.s.	|	|	|	|	|	|
Eurozone (ezone)	++	n.s.	|	|	|	|	|
Stoxx Pharma (pbtm)	---	---	---	|	|	|	|
Stoxx Biotech (bttm)	++	n.s.	++	+++	|	|	|
High-Tech Index (tech)	+++	+++	+++	+++	+++	|	|
Intra-Sample Index (btindex)	+++	+++	+++	+++	+++	+++	|

+++/++/+ Row index R^2 significantly larger than row index R2 at 1%/5%/10% levels
---/--/- Column index R^2 significantly larger than column index R2 at 1%/5%/10% levels

Source: Own Analysis

Table 117: Significance of Wilcoxon Paired-Rank Tests on R2 Statistics

Indices	Mean	Median	Stoxx600/ Local	Stoxx600/ StoxxBT	Local/ StoxxBT	Stoxx600/ Local/ Intra
Stoxx600 (stoxx)	0.0506	0.0365	+++	+++	+++	+++
Local Indices (local)	0.0519	0.0358	+++	+++	+++	+++
StoxxBiotech (bttm)	0.0670	0.0432	n.s.	+++	+++	+++
Stoxx600/Local	0.0559	0.0437	|	|	|	|
Stoxx600/StoxxBT	0.0745	0.0527	+++	|	|	|
Local/StoxxBT	0.0795	0.0558	+++	+++	|	|
Stoxx600/Local/Intra	0.0797	0.0562	+++	+++	n.s.	|

+++/++/+ Row index R^2 significantly larger than row index R2 at 1%/5%/10% levels
---/--/- Column index R^2 significantly larger than column index R2 at 1%/5%/10% levels

Source: Own Analysis

Cross-Sectional Methodology

Equations illustrating general OLS regression set-up.

	Standard Algebraic Formulation		Matrix Formulation
(32)	$Y_i = \alpha + \sum_{v=1}^{V} \beta_v X_i + \varepsilon_i$	or	$Y = X\beta + \varepsilon$

where:
- y_i (Y) = (matrix of) observed realizations of dependent variables
- α = estimated intercept
- β_i = (vector of) estimated coefficients on independent variables
- $x_{i,j}$ (X) = (matrix of) observed realizations of independent variables
- ε_i (ε) = Error term (vector)

with

(33) $$\hat{\beta} = \frac{\sum x_t y_t - N\overline{xy}}{\sum x_t^2 - N\overline{x}^2} \quad \text{or} \quad \hat{\beta} = (X'X)^{-1}X'y$$

(34) $$\hat{\alpha} = \overline{y} - \hat{\beta}\overline{x}$$

where: x_t (X) = (matrix of) observed realizations of independent variables

y_t (y) = (vector of) observed realizations of dependent variables

x[bar] = average value of independent variables

y[bar] = average value of dependent variables

X' = Transposed matrix of observed independent variable realizations

To account for the effects of heteroskedasticity, consistent standard errors are calculated following the approach proposed by White (1980):

(35) $$var\left(\hat{\beta}_j\right) = \frac{\sum \hat{w}_{ij}^2 \hat{u}_i^2}{\left(\sum \hat{w}_{ij}^2\right)^2}$$

where: w_{ij} [hat] = estimated error term for variable i and observation j

u_i [hat] = estimated error term for variable i

Table 118: Overview of Regression Assumptions

Assumption / Description		(Berry 1993) (p. 12)	(Gujarati 2003) (p. 65-76)
(a)	All independent variables are metric or dichotomous in nature. The dependent variable is metric. All variables are free from measurement error.	■	Linearity / Correct Specification
(b)	All explanatory variables have non-zero variance, i.e., are not constant across all observations.	■	■
(c)	There are no exact linear relationships between any two explanatory variables (i.e. no perfect multicollinearity).	■	■
(d)	The mean value of the error term is zero.	■	■

Table 118 (Continued)

Assumption / Description		(Berry 1993) (p. 12)	(Gujarati 2003) (p. 65-76)
(e)	The error terms are uncorrelated with all explanatory variables	■	■
(f)	The conditional variance of the error term (sigma2) is constant, i.e., the estimation results are homoskedastic	■	■
(g)	The error terms of any two observations are uncorrelated, i.e., the estimation errors are free from autocorrelation.	■	■
(h)	The error terms are normally distributed	■	
(i)	Fixed Resampling		■

Source: Own Compilation

Table 119: Two-Way Panel-Data Effects

Description / Discussion
In addition to purely cross-sectional (i.e., unit-specific) effects, unobserved heterogeneity may exist along the time-series dimension of such panel data sets. In line with prior alliance-related research, however, the present study focuses on the distractions associated with cross-sectional pooling, i.e., systematic differences in value creation at the firm level (rather than the transaction level). It does not further consider the sequence (i.e., timewise order) of alliance announcements for two reasons: On one hand, a visual inspection of residuals over calender time did not further any evidence of timewise autocorrelation. On the other hand, using a time-series component (e.g., two-way fixed or random effects) may not accurately reflect firm-specific learning, since such effects are expected to be non-linear, varying with the number of prior alliances and the time since the last alliance was formed.[577]

[577] Nonetheless, it is tempting to endogenously account for learning effects often argued to be explain a positive relationship between abnormal returns and the number of alliances [cf. (Anand and Khanna 2000), (Kale et al. 2002)]. If such effects were truly due to learning rather than reputation, an increase in abnormal returns should be observable across sequential alliances of the same companies within the sample. A more homogeneous data set would, however, be required.

Table 120: Conceptual Framework for Model-Selection

	No Timewise Autocorrelation in Error	Timewise Autocorrelation Present
Cross-sectional dominance (N>T)		
No between-unit effects	Ordinary Least Squares (OLS)	*
Between-unit effects present		
(Fixed)	Least Squares with Dummy Variables (LSDV)	*
(Random)	Error Components (GLSE)	*
Time-serial dominance (T>N)		
No between-unit effects	Ordinary Least Squares (OLS)	GLS-ARMA
Between-unit effects present	Least Squares with Dummy Variables (LSDV)	GLS-ARMA (with Dummy Variables)

* No applicable models [at time of publication] Shaded area – Focus of present study
Source: (Stimson 1985), p. 929

Table 121: Alternative Specification of Selection Model

Description / Discussion
An alternative to explicitly modelling the time to alliance formation (i.e., as a series of days without events) was also employed. In this model, only the time to each event occurrence is considered (i.e., intermediate day without events are omitted from the data set). This approach, however, has one primary limitation. While most explanatory variables vary over time, the model does not explicitly allow for time-varying covariates. Instead, the time-varying explanatory variables represents their value at the time of alliance formation (or censoring). That is, the coefficients on these variables cannot be interpreted relative to non-event (or non-censoring, i.e., out-of-sample) time periods. This limitation, however, does not pose a significant threat to the validity of the study for two reasons. First, the objective is not to analyze the factors influencing alliance formation in general, but rather to account for the aggregate effects of alliance formation hazard on the observed AR (within-sample). Second, the benefits from explicitly modeling time-varying covariates would be limited and potentially offset by a loss in information. In particular, since alliance formation is quite frequent relative to (substantial) changes in the time-varying covariates, the benefits of many

time-varying covariates would be low and may be more than offset by losses in information. On one hand, firm characteristics (e.g., size, patent count) and the market activity index were measured on an annual and quarterly basis, respectively. Similarly, stock-market indicators were estimated over a 200-day period. On the other hand, 23.86% (47.27%) of all formation announcements occurred within 30 (90) from the previous one.

Table 122: Issues Resolved in Methdology Section

Stage	Concerns	Methodology
Sample Selection		
– **Sample of Firms**	Validity of Classification Schemes used for Sample Selection	– Network-based consensus analysis of alternative classification providers
	Validity of Firm Identification (pure-play biotechnology firms)	– Rigid selection algorithm based on high level of consensus (>90% of ANL)
– **Sample of Event Announcements**	Comprehensive identification of alliance-related events (and correct timing)	Comparison of present sample with alternative – Industry-specific (ReCap) – Country specific (DGAP) information sources.
Data Coding	Validity of Coding Scheme	Alignment of coding scheme with prior research or reputable industry-specific sources
	Consistency of Data Coding	Recoding exercise involving recoders
Event Study		
– **Abnormal Return Estimation**	Noise resulting from unavailable return data (infrequent trading)	Exclusion of missing return and subsequent one
	Distortion resulting from Confounding Events	Exclusion of Events with Confounding News during relevant Event Window

Appendix to Chapter 5: Results of Empirical Investigation

Event Study Results

Table 123: Summary of Event Study Model Estimation

Model	Market Model (Stoxx 600)	2-Factor Model (Local/Stoxx BT)	Intra-Sample Index Model
N	690	690	690
Mean F-Statistic	24,56	19,45	39,77
Median F-Statistic	14,97	10,98	28,70
Highest F-Statistic	126,64	189,80	234,06
Lowest F-Statistic	0,00	0,03	0,02
Number (Share) failing to reach 5% significance level	92 (13.3%)	100 (14.5%)	11 (1.6%)
F-Statistic Correlation			
– Market Model	1	|	|
– 2-Factor Model	0,7228	1	|
– Intra-Sample Model	0,8490	0,6510	1

Source: Own Analysis

Table 124: Correlations of ARs across Estimation Models and Event Windows

	arMM	ar2F	arBT	arBTi	carMM2	car2F2	carBT2	carBTi2	carMM3	car2F3	carBT3	carBTi3	carMM4	car2F4	carBT4
arMM	1														
ar2F	0.9955 ***	1													
arBT	0.9855 ***	0.9853 ***	1												
arBTi	0.9859 ***	0.9844 ***	0.9928 ***	1											
carMM2	0.9304 ***	0.9236 ***	0.9084 ***	0.9083 ***	1										
car2F2	0.9292 ***	0.9313 ***	0.9108 ***	0.9091 ***	0.9923 ***	1									
carBT2	0.9221 ***	0.9197 ***	0.9284 ***	0.9202 ***	0.9776 ***	0.976 ***	1								
carBTi2	0.9195 ***	0.9166 ***	0.916 ***	0.9232 ***	0.9785 ***	0.9756 ***	0.9875 ***	1							
carMM3	0.8978 ***	0.8894 ***	0.8785 ***	0.8774 ***	0.9492 ***	0.94 ***	0.9298 ***	0.9274 ***	1						
car2F3	0.8961 ***	0.8965 ***	0.8811 ***	0.8772 ***	0.9441 ***	0.9497 ***	0.9315 ***	0.9271 ***	0.9897 ***	1					
carBT3	0.8804 ***	0.8779 ***	0.8913 ***	0.8784 ***	0.919 ***	0.9173 ***	0.9463 ***	0.927 ***	0.9685 ***	0.9689 ***	1				
carBTi3	0.8837 ***	0.8802 ***	0.8836 ***	0.888 ***	0.9238 ***	0.9197 ***	0.9368 ***	0.9449 ***	0.9714 ***	0.9684 ***	0.9818 ***	1			
carMM4	0.8294 ***	0.8182 ***	0.8003 ***	0.8036 ***	0.8788 ***	0.8677 ***	0.8437 ***	0.847 ***	0.9361 ***	0.9197 ***	0.8856 ***	0.8952 ***	1		
car2F4	0.8375 ***	0.8348 ***	0.8124 ***	0.8131 ***	0.8826 ***	0.885 ***	0.8549 ***	0.8555 ***	0.9353 ***	0.937 ***	0.8956 ***	0.9022 ***	0.9881 ***	1	
carBT4	0.823 ***	0.8171 ***	0.8261 ***	0.8167 ***	0.863 ***	0.8598 ***	0.8773 ***	0.8637 ***	0.9178 ***	0.913 ***	0.9347 ***	0.9217 ***	0.958 ***	0.9585 ***	1
carBTi4	0.8221 ***	0.8152 ***	0.8114 ***	0.8197 ***	0.862 ***	0.8554 ***	0.8571 ***	0.8714 ***	0.9154 ***	0.9045 ***	0.9029 ***	0.9286 ***	0.9682 ***	0.9643 ***	0.9746 ***

***/**/* indicates significance at 1%/5%/10% levels
Source: Own Analysis

Table 125: ARs to Alliance Formation Announcements by Day of Event Period

Day	N	Market Model (STOXX600)				2-Factor-Model (Local/STOXXBT)				Market Model (Intra-Sample Index)			
		AAR	Z (DW)	Z (BW)	Z (CS)	AAR	Z (DW)	Z (BW)	Z (CS)	AAR	Z (DW)	Z (BW)	Z (CS)
-10	358	0.0020	0.84	0.78	0.85	0.0019	0.8648	0.71	0.81	0.0034	1.61	1.30	1.50
-9	363	-0.0041	-1.55	-1.59	-1.41	-0.0030	-1.309	-1.16	-1.07	-0.0036	-1.62	-1.39	-1.24
-8	367	-0.0016	-0.64	-0.60	-0.58	-0.0021	-0.913	-0.78	-0.77	-0.0031	-1.25	-1.19	-1.26
-7	361	0.0011	0.35	0.42	0.52	0.0008	0.3998	0.32	0.40	0.0007	0.30	0.27	0.34
-6	361	0.0024	0.91	0.91	0.81	0.0022	0.8716	0.85	0.76	0.0012	0.26	0.47	0.44
-5	359	0.0039	1.52	1.49	1.37	0.0038	1.3668	1.44	1.38	0.0036	1.38	1.40	1.28
-4	365	0.0023	1.00	0.86	0.95	0.0015	0.7437	0.57	0.64	0.0015	0.75	0.59	0.66
-3	363	0.0032	1.62	1.24	1.64	0.0023	1.1257	0.87	1.19	0.0023	1.24	0.90	1.22
-2	363	-0.0003	-0.12	-0.11	-0.10	0.0001	0.0201	0.05	0.05	0.0021	0.74	0.81	0.79
-1	355	0.0003	0.41	0.12	0.13	0.0005	0.3948	0.18	0.21	0.0018	0.99	0.68	0.79
0	338	0.0283	13.29 ***	10.88 ***	5.10 ***	0.0283	13.534 ***	10.78 ***	5.13 ***	0.0304	14.41 ***	11.70 ***	5.71 ***
1	356	0.0011	0.76	0.44	0.52	0.0009	0.6322	0.34	0.41	0.0015	0.89	0.57	0.69
2	357	-0.0048	-1.83 *	-1.84 *	-2.64 ***	-0.0038	-1.336	-1.44	-2.07 **	-0.0048	-1.98 **	-1.84 *	-2.62 ***
3	359	-0.0001	0.07	-0.05	-0.06	0.0006	0.4401	0.23	0.26	-0.0010	-0.39	-0.40	-0.48
4	359	-0.0031	-0.18	-1.19	-1.44	-0.0038	-0.522	-1.44	-1.80 *	-0.0027	-0.23	-1.05	-1.33
5	355	-0.0009	-0.84	-0.34	-0.40	-0.0012	-1.011	-0.45	-0.56	-0.0003	-0.53	-0.10	-0.13
6	357	0.0002	0.02	0.06	0.07	-0.0001	-0.107	-0.03	-0.04	0.0007	0.07	0.25	0.30
7	343	0.0018	0.80	0.68	0.60	0.0020	0.9303	0.75	0.68	0.0022	0.99	0.83	0.77
8	356	-0.0052	-2.59 ***	-2.00 **	-2.30 **	-0.0047	-2.323 **	-1.80 *	-2.15 **	-0.0051	-2.48 **	-1.97 **	-2.47 **
9	359	0.0024	1.31	0.94	0.89	0.0026	1.6045	1.01	0.97	0.0015	1.01	0.59	0.58
10	361	-0.0021	-1.54	-0.80	-0.93	-0.0023	-1.623	-0.86	-1.02	-0.0004	-0.70	-0.15	-0.18

Source: Own Analysis ***/**/* indicates significance at 1%/5%/10% levels

Figure 60: Summed Abnormal Returns to Alliance Formation Announcements

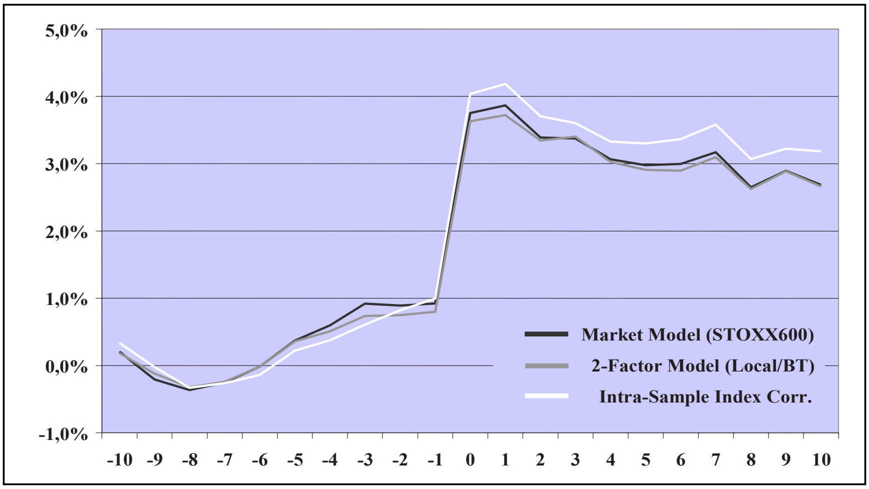


Table 126: Abnormal Returns by Event Category for Different Event Windows (based on Stoxx600 Market Model)

Event	21-Day Window (-10/+10)						14-Day Window (-10/+3)						5-Day Window (-2/+2)					
	N	CAAR	DW	BW	CS	Corr	N	CAAR	DW	BW	CS	Corr	N	CAAR	DW	BW	CS	Corr
Formation	161	0.0136					228	0.0290	***	***		***	290	0.0250	***	***		**
Expansion	14	-0.0243					23	0.0224					34	0.0432	***	**		
Extension	5	-0.0112					7	-0.0210					11	0.0025				
Modification	10	-0.0487					15	-0.0003					17	0.0100				
Milestone	37	-0.0142					56	0.0274					74	0.0118				
Clinical	8	0.0121					9	0.0145					13	0.0059				
Termination	11	-0.0285	*				14	-0.0018	**				19	0.0487			*	
Multiple	5	0.0587					8	0.0751	**	**			9	0.0956	***	***	*	**
Other	12	0.0921	***	**			15	0.1083	***	***	**		17	0.0411	**	**		
Rumor	4	-0.0504					4	-0.0613	*				6	0.0804		***		
Follow	13	0.0085					19	-0.0120					38	-0.0080				

Event	5-Day Window (-3/+1)						3-Day Window (-1/+1)						1-Day Window (day 0)					
	N	CAAR	DW	BW	CS	Corr	N	CAAR	DW	BW	CS	Corr	N	CAAR	DW	BW	CS	Corr
Formation	295	0.0328	***	***	***	***	311	0.0300	***	***	***	***	335	0.0300	***	***	***	***
Expansion	34	0.0455	***	***			37	0.0390	***	***	*	*	39	0.0260	***	***	*	***
Extension	13	0.0032					14	0.0049					14	0.0007				
Modification	17	0.0133					17	0.0100					17	0.0045				
Milestone	75	0.0321	***	***			81	0.0300	***	***		*	87	0.0348	***	***	***	***
Clinical	12	0.0241				**	14	-0.0088				*	17	0.0131				***
Termination	18	0.0548			**		19	0.0386			**		20	-0.0184	***			**
Multiple	9	0.0926	***	***	*		9	0.0685	***	***		**	10	0.0380	***	***		**
Other	17	0.0579	***	***	**	*	18	0.0417	***	***	**		24	-0.0079				
Rumor	8	0.0642		**			9	0.0610		***			10	0.0090				
Follow	38	-0.0104					39	0.0051					43	-0.0060				

***/**/* indicates significance at 1%/5%/10% levels
DW/BW/CS/Corr – Dodd-Warner/Brown-Warner/Cross-sectional/Corrado Tests
Source: Own Analysis

Univariate Correlation Analyses

Table 127: Complete Correlations between Firm-Specific Variables

	age	agep	focalstaff	focalsales	focalassets	focalmve	experience	focalp5	focalp3	focalpr	focalebit	focalocf	focalncf	focalbvd
age	1													
agep	0.59 ***	1												
focal staff	0.7764 ***	0.7691 ***	1											
focal sales	0.7439 ***	0.7424 ***	0.9223 ***	1										
focal assets	0.6481 ***	0.7381 ***	0.913 ***	0.9262 ***	1									
focal mve	0.6582 ***	0.69 ***	0.8601 ***	0.8443 ***	0.8621 ***	1								
experience	0.0661	0.4231 ***	0.3827 ***	0.3336 ***	0.536 ***	0.255 ***	1							
focal p5	0.0039	0.2525 ***	0.1924 ***	0.0096	0.183 ***	0.0986 *	0.4105 ***	1						
focal p3	-0.0768	0.1255 **	0.1953 ***	0.0743	0.2881 ***	0.1471 ***	0.5075 ***	0.7424 ***	1					
focal pr	-0.1623 ***	-0.145 ***	-0.0408	0.0193	0.0993 *	0.0048	0.1458 ***	-0.1634 ***	0.2697 ***	1				
focal ebit	0.4431 ***	0.3205 ***	0.3948 ***	0.5651 ***	0.3816 ***	0.4878 ***	-0.165 ***	-0.3596 ***	-0.3559 ***	-0.0024	1			
focal ocf	0.7016 ***	0.6607 ***	0.836 ***	0.9308 ***	0.8891 ***	0.7879 ***	0.302 ***	-0.0035	0.0978 *	0.0764	0.5343 ***	1		
focal ncf	0.2311 ***	0.1547 ***	0.2241 ***	0.2798 ***	0.2734 ***	0.2845 ***	-0.0237	-0.1279 **	-0.0273	0.087	0.2242 ***	0.378 ***	1	
focal bvd	-0.538 ***	-0.504 ***	-0.6456 ***	-0.8067 ***	-0.8104 ***	-0.7798 ***	-0.233 ***	0.069	-0.0652	-0.1644 ***	-0.5732 ***	-0.7975 ***	-0.4237 ***	1
focal q	-0.0184	-0.0089	-0.0092	0.0205	-0.0803	0.2152 ***	-0.1888 ***	-0.1675 ***	-0.0929	-0.1038 *	0.1497 **	0.0576	0.0095	0.0441

***/**/* indicates significance at 1%/5%/10% levels

Table 128: Discussion of Correlations Between ARs and Transaction-Level Variables

Contextual Transaction Characteristics
• Somewhat surprisingly, the industry-specific variables addressing the size (and competitiveness) of market segments appear to have little impact on value creation. Among all medical-indication dummy variables, the one indicating cancer treatments (i_cancer) being targeted is the only one standing in its relation to abnormal returns. However, the positive association is only significant for the announcement day itself. This marginal significance (and the insignificance of other indication dummies) may be attributed to several factors: First, the fairly large share of announcements not indicating the targeted area of indication may distort this relation, since all industry dummies are subject to joint hypotheses problems, i.e., that the value of collaboration is associated with the given indication and with the fact that the indication is indicted in the announcement. Second, market size and competition may effectively offset each other resulting in different indications having similar valuation effects. Given the advanced state of commercial considerations driving resource allocation decisions in the global pharmaceutical industry, this notion is at least plausible. Third, a similar netting-effect may appear due to differences in technological uncertainty. For instance, since a plethora of approaches has been taken to combat cancer, the value of each potential cancer drug may be limited not only by competition, but also by the greater complexity of cancer treatment. • Different stages along the drug discovery process may be associated with diverging abnormal returns. Most specifically, it appears that advanced clinical-stage projects (s_clinical3) reap the highest collaborative gains. While this effect is to be considered cautiously due to the relatively small number of clinical phase 3 collaborations (5), no other stage dummy is significantly correlated to abnormal returns. This somewhat counters the general notion of more advanced projects systematically yielding higher abnormal returns. For instance, this effect may even be reversed with regard to commercialized products. • While indicators of market size and relative advancement thus provide limited insight into value generation, the business models pursued collaboratively is significantly related to abnormal returns. Specifically, drug development exhibits a consistently positive association across all return models and event windows. Conversely, platform technologies are linked to lower abnormal returns, with service provision, diagnostics, and other products not significantly correlated to value creation.

Consequently, the data clearly suggests that firms may benefit most from collaborating in comparably risky businesses. Given the prevalence of 'outbound' transactions, it appears that cashing in on proprietary drug development projects may be a more profitable strategy than leveraging proprietary technologies.

- This notion is also supported with regard to the functional area of collaboration. While purely commercialization-oriented agreements are not systematically linked to value creation, collaboration focusing on R&D exhibit a significantly positive relationship. Such agreements mostly relate to the joint continuation of drug development projects or research services.

Structural Transaction Characteristics

Structural transaction characteristics have a significant relation to abnormal returns

Generally, the structural elements of outbound transactions, such as outbound licenses, partner firms' equity investments, and options granted to partnering firms, are positively associated with abnormal returns. Similarly, incoming payments of either guaranteed, milestone, or royalty type are positively correlated with all CAR measures.

Additionally, the reported value of a collaboration as well as the mere fact that value is being reported are positively related to value creation. While the latter reflects a signaling effect, the extent of the correlation of 'value' and abnormal returns suggests that there may also be a substantive effect of collaboration value.

Finally, alliances of limited duration (timelimit) and geographic scope (regional) are associated with higher CARs. Similar to the case of nominal collaboration value, the length of duration (time) is significantly related to abnormal returns as well and exceeds the strength of collaboration of mere time-limitedness.

While several findings thus point towards structural alliance characteristics having an impact of collaborative value creation, these effect need to be considered with caution. Specifically, many of them may well be due to the generally higher returns generated by outbound alliances (see above).

Table 129: Discussion of Correlations Among Transaction-Level Variables

Discussion of Correlations Among Explanatory Variables (Transaction Level)
Contextual transaction characteristics exhibit manifold correlations reaching significance. However, many of these reflect definitory relationships, such as commercialization alliances generally being in the commercialization stage. More importantly, the business model variables correlate significantly with the functional alliance foci. Specifically, drug-discovery alliances (m_drug) tend to focus on R&D (f_rnd), service alliances (m_service) mostly relate to manufacturing activities (f_manufact), and alliances involving platform-technologies (m_technology) generally concern commercialization (f_commercial). While this limits the concurrent use of function and business-model variables, the multifaceted transaction context variables need to be considered in greater detail. Structural transaction characteristics, as expected, are highly correlated amongst themselves. In particular, alliance direction (d_outbound/d_inbound) is related to transaction structure variables [with the exception of incoming equity investments (equityshort)] and payment structure.[578] Conversely, correlations between alliance direction and transaction value (value/valuereport) as well as restrictions (time/regional) are only marginally significant. While transaction structure characteristics are relatively little correlated amongst themselves, compensation structure variables are mostly bundled, i.e., incoming or outbound payments of different types. All in all, using alliance direction dummies as control variables may capture many of the relevant structural variables, leaving only particular effects of transaction values and boundaries insufficiently accounted for.

578 As a result, transaction and payment structure variables are also correlated. However, the level of association is smaller, generally below the threshold of 0.4 generally considered critical for cross-sectional analysis [e.g., (Gujarati 2003)].

Table 130: Correlations of Environment-Related Variables with CAR Measures

Variable	carMM2	car2F2	carBT2	carBTi2	arm	carMM3	carMM4
Medical Indication (Control 1)							
i_cns	0.0118	0.0038	0.0153	0.022	0.0088	-0.0216	-0.0245
i_cancer	0.0673	0.063	0.0731	0.0772	0.0941 *	0.0536	0.0688
i_cadiovas	-0.0311	-0.0315	-0.0379	-0.0307	-0.0712	-0.0309	-0.0263
i_infectious	0.0066	0.0198	-0.0011	-0.0077	0.0253	0.0242	-0.0112
i_inflammation	-0.0134	-0.0098	-0.0016	0.0004	-0.0336	-0.0074	-0.0068
i_metabolic	0.002	0.0023	0.0293	0.0141	0.0047	0.0139	-0.0035
i_other	-0.0089	-0.0099	-0.0126	-0.0108	-0.0306	0.0175	0.0298
i_respiratory	-0.0059	-0.0044	-0.001	-0.0028	-0.0312	0.0095	0.0255
i_various	-0.026	-0.0293	-0.0227	-0.0257	-0.0318	-0.0646	-0.0711
Partner-Relatedness (Control 2)							
ptype_bt	-0.0755	-0.0701	-0.0798	-0.0623	-0.093 *	-0.0715	-0.0363
ptype_oth	-0.0169	-0.022	-0.0218	-0.0262	-0.0245	-0.0302	-0.058
ptype_ph	0.1374 **	0.132 **	0.1359 **	0.1248 **	0.1703 ***	0.1641 ***	0.1207 **
ptype_res	-0.0538	-0.0488	-0.0379	-0.0463	-0.0606	-0.0835	-0.0446
International Scope Partner Origin (Control 3)							
pregion_eu	0.042	0.0566	0.0521	0.0447	0.0581	0.0078	-0.0575
pregion_j	-0.0594	-0.0602	-0.066	-0.0682	-0.0474	-0.073	-0.0575
pregion_oth	-0.0829	-0.0812	-0.086	-0.0822	-0.0811	-0.0649	-0.0647
pregion_us	0.0171	0.0029	0.0115	0.0184	-0.0017	0.0436	0.1041 *
Market Climate (Control 4)							
mktretsx	-0.0172	-0.0028	0.0295	0.0302	-0.0312	-0.005	-0.0303
mktretsb	-0.0777	-0.0561	-0.0115	-0.0046	-0.0806	-0.0917	-0.1178 **
mktretbt	-0.0717	-0.0509	-0.0051	0.0003	-0.0746	-0.0733	-0.0967 *
Alliance Activity (Hypothesis 10)							
mktactivity	-0.0375	-0.0456	-0.0465	-0.0498	-0.0408	-0.0481	-0.0369
Market Volatility (Hypothesis 11)							
mktvolsx	0.0245	0.022	-0.0223	-0.0188	0.079	0.035	0.0552
mktvolsb	-0.0816	-0.0662	-0.0582	-0.047	-0.0957 *	-0.1231 **	-0.1433 **
mktvolbt	-0.1003 *	-0.0869	-0.0836	-0.0733	-0.1142 **	-0.1372 **	-0.1472 **

All figures indicate standard correlation coeffiicients (spearman rank correlations for dummy variables)

***/**/* indicates significance at 1%/5%/10% levels

Table 131: Correlations of Firm-Specific Variables with CAR Measures

Variable	carMM2	car2F2	carBT2	carBTi2	arMM	carMM3	carMM4
Focal Firm Size (Control 5)							
age	-0.0795	-0.086	-0.0893	-0.0828	-0.0702	-0.0587	-0.0462
agep	-0.0736	-0.0714	-0.0867	-0.0813	-0.0708	-0.068	-0.0588
focalstaff	-0.1167 **	-0.1252 **	-0.1289 **	-0.1233 **	-0.1198 **	-0.0971 *	-0.0778
focalsales	-0.1128 **	-0.1161 **	-0.1203 **	-0.109 *	-0.1115 *	-0.0974 *	-0.0905
focalassets	-0.1101 **	-0.117 **	-0.1241 **	-0.1147 **	-0.1233 **	-0.0919	-0.0743
focalmve	-0.1086 *	-0.1125 **	-0.1153 **	-0.1061 *	-0.1095 *	-0.0866	-0.072
Partner Firm Resources (Control 6)							
pstatus	0.1136 **	0.1042 *	0.1094 **	0.1211 **	0.1138 **	0.125 **	0.1161 **
ppstatus	0.0838	0.0767	0.0746	0.0887	0.09	0.1009 *	0.0942
pp	0.0773	0.075	0.07	0.0783	0.1109 **	0.0757	0.0841
ppp	-0.0397	-0.0382	-0.037	-0.0379	-0.0358	-0.0496	-0.0546
pppp	0.0479	0.0465	0.0428	0.0496	0.0787	0.0414	0.0462
ptrans	0.1514 ***	0.145 ***	0.146 ***	0.1452 ***	0.172 ***	0.1957 ***	0.1931 ***
pptrans	-0.0299	-0.0268	-0.0374	-0.0359	-0.0259	-0.03	-0.0147
ppptrans	0.1215 **	0.1172 **	0.1131 **	0.1132 **	0.1404 **	0.1618 ***	0.1658 ***
Focal Firm Alliance Experience (Control 7)							
experience	-0.0893	-0.0905	-0.0994 *	-0.1014 *	-0.1118 **	-0.098 *	-0.0679
Focal Firm Performance (Control 9)							
focalebit	-0.046	-0.0447	-0.0414	-0.0327	-0.0395	-0.0316	-0.0352
focalocf	-0.082	-0.0875	-0.089	-0.0806	-0.0847	-0.0673	-0.0618
focalncf	0.0311	0.0126	0.018	0.0251	-0.0104	0.0314	0.0378
focalq	0.0247	0.0365	0.0325	0.0417	-0.0018	0.0059	-0.0125
Focal Resources (Additional Variables)							
focalp5	-0.0607	-0.06	-0.0853	-0.0841	-0.0563	-0.0435	-0.0187
focalp3	-0.1185 **	-0.1287 **	-0.1443 ***	-0.1533 ***	-0.126 **	-0.101 *	-0.0689
focalpr	-0.0515	-0.0679	-0.0511	-0.0688	-0.0478	-0.0711	-0.0751

All figures indicate standard correlation coeffiicients (spearman rank correlations for dummy variables)

***/**/* indicates significance at 1%/5%/10% levels

Table 132: Correlations of Transaction-Specific Variables with CAR Measures

Variable	carMM2	car2F2	carBT2	carBTi2	arMM	carMM3	carMM4
Prior Relations between Partners (Control 8)							
prior	0.0804	0.0708	0.0661	0.0611	0.1111 **	0.1237 **	0.1075 *
Alliance Function (Control 10)							
f_manufact	-0.0422	-0.0402	-0.0554	-0.0487	-0.0283	-0.0646	-0.0713
f_commercial	-0.0875	-0.0923 *	-0.0766	-0.0744	-0.0634	-0.0724	-0.0959 *
f_rnd	0.1056 *	0.1091 **	0.1024 *	0.0967 *	0.0756	0.1024 *	0.1289 **
scope2	0.0424	0.0376	0.0377	0.0497	0.0394	0.0268	0.0055
Development Stage (Hypothesis 4)							
exploration	0.1085 **	0.1041 *		0.0917 *			
exploitation	-0.1085 **	-0.1041 *		-0.0917 *			
Business Model (Hypothesis 5)							
m_diag	0.0316	0.0328	0.0366	0.0427	0.0206	0.0197	0.0356
m_drug	0.1353 **	0.1322 **	0.13 **	0.136 **	0.1358 **	0.1366 **	0.1322 **
m_hybrid	-0.0249	-0.0248	-0.0071	-0.0241	-0.0127	-0.0341	-0.0367
m_other	-0.0414	-0.0407	-0.0373	-0.0341	-0.0233	-0.0377	-0.0248
m_service	-0.009	-0.0006	-0.0144	-0.0236	-0.0288	-0.0104	-0.0377
m_technology	-0.1351 **	-0.1407 **	-0.1329 **	-0.1285 **	-0.1163 **	-0.1284 **	-0.104 *
Direction of Resource Transfers (Hypothesis 6)							
d_inbound	-0.0719	-0.0629	-0.0689	-0.0467	-0.1093 *	-0.1106 *	-0.0789
d_joint	-0.0497	-0.0608	-0.0613	-0.0634	-0.0529	-0.055	-0.0403
d_outbound	0.1054 *	0.1062 *	0.1121 **	0.0938 *	0.1417 **	0.1438 **	0.1029 *

All figures indicate standard correlation coeffiicients (spearman rank correlations for dummy variables)

***/**/* indicates significance at 1%/5%/10% levels

Table 133: Correlations of Structural Transaction Characteristcis with CAR Measures

Variable	carMM2	car2F2	carBT2	carBTi2	arMM	carMM3	carMM4
Collaboration Structure (Control 11)							
licshort	0.1197 **	0.1111 **	0.1358 **	0.1315 **	0.1621 ***	0.1309 **	0.1291 **
liclong	-0.1059 *	-0.1062 *	-0.0951 *	-0.0862	-0.0866	-0.1241 **	-0.0782
equityshort	0.2836 ***	0.2805 ***	0.2804 ***	0.2735 ***	0.2895 ***	0.2666 ***	0.243 ***
equitylong	-0.0082	-0.0129	0.0127	0.0106	-0.028	-0.0506	-0.0885
jv	0.002	-0.0024	-0.0086	-0.0072	-0.0027	0.0233	0.0345
Financial Payments (Control 12)							
payin	0.1504 ***	0.1498 ***	0.1659 ***	0.1917 ***	0.1787 ***	0.1590 ***	0.1100 *
payout	-0.1261 **	-0.1324 **	-0.1285 **	-0.1093 **	-0.1268 **	-0.0855	-0.0663
value	0.5877 ***	0.5886 ***	0.5878 ***	0.583 ***	0.6192 ***	0.558 ***	0.5455 ***
valuereport	0.2475 ***	0.2378 ***	0.2674 ***	0.2594 ***	0.2894 ***	0.2708 ***	0.2211 ***
Structure of Financial Payments (Hypothesis 7)							
guarantlong	0.231 ***	0.2284 ***	0.2312 ***	0.2311 ***	0.256 ***	0.2525 ***	0.233 ***
guarantshort	-0.0458	-0.0512	-0.0412	-0.0287	-0.0481	-0.0353	-0.0049
milestonelong	0.1968 ***	0.1923 ***	0.2088 ***	0.2034 ***	0.1934 ***	0.214 ***	0.1813 ***
milestoneshort	-0.0406	-0.0459	-0.0313	-0.0201	-0.0504	-0.0441	-0.0324
royaltylong	0.1767 ***	0.1717 ***	0.1807 ***	0.1853 ***	0.1842 ***	0.1997 ***	0.1792 ***
royaltyshort	-0.0552	-0.0645	-0.0576	-0.0454	-0.0654	-0.0604	-0.0536
Time-Limitedness and Contractual Flexibilities (Hypotheses 8-9)							
time	0.2416 ***	0.2325 ***	0.2515 ***	0.2423 ***	0.2342 ***	0.2401 ***	0.1954 ***
timelimit	0.1281 **	0.1237 **	0.1351 **	0.119 **	0.1532 ***	0.1216 **	0.0785
regional	0.111 **	0.1101 **	0.1363 **	0.1379 **	0.1225 **	0.1292 **	0.0749
optionshort	0.0828	0.0915 *	0.0885	0.0922 *	0.1131 **	0.0891	0.0717
optionlong	-0.0406	-0.0327	-0.0354	-0.0417	-0.0604	-0.0439	-0.0407

All figures indicate standard correlation coefficients (spearman rank correlations for dummy variables)

***/**/* indicates significance at 1%/5%/10% levels

Table 134: Correlations of Transaction-Context Characteristics with Age and Size

Variable	age	agep	focalstaff	focalsales	focalassets	focalmve
Prior Relations between Partners (Control 8)						
prior	-0.0114	0.0501	-0.0084	-0.0192	0.0209	0.0184
Alliance Function (Control 10)						
f_manufact	0.0974 *	0.0424	0.0085	-0.0157	-0.0184	-0.0274
f_commercial	0.1165 **	0.079	0.1778 ***	0.1514 ***	0.1388 **	0.0947 *
f_rnd	-0.1628 ***	-0.0977 *	-0.1729 ***	-0.1359 **	-0.1214 **	-0.0746
Development Stage (Hypothesis 4)						
exploration	-0,068	-0,0617	-0,0897	-0,1329 **	-0,1093 **	-0,0082
exploitation	0,068	0,0617	0,0897	0,1329 **	0,1093 **	0,0082
Business Model (Hypothesis 5)						
m_diag	-0.0609	-0.0955 *	-0.0525	-0.0577	-0.0918 *	-0.0626
m_drug	0.1699 ***	0.1739 ***	0.0668	0.1748 ***	0.1589 ***	0.0181
m_hybrid	-0.031	-0.0523	-0.0531	-0.0334	-0.0573	0.0035
m_other	-0.031	-0.0239	-0.0175	-0.0271	-0.0299	-0.0149
m_service	-0.0691	-0.0293	-0.0654	-0.0971 *	-0.0723	-0.0591
m_technology	-0.0677	-0.0874	0.0399	-0.042	-0.03	0.0716
Direction of Resource Transfers (Hypothesis 6)						
d_inbound	0.1428 ***	0.2166 ***	0.2527 ***	0.28 ***	0.2681 ***	0.2727 ***
d_joint	-0.0671	-0.1403 **	-0.1275 **	-0.0605	-0.0806	-0.0627
d_outbound	-0.074	-0.0797	-0.1193 **	-0.2031 ***	-0.1761 ***	-0.1894 ***

All figures indicate standard correlation coeffiicients (spearman rank correlations for dummy variables)

***/**/* indicates significance at 1%/5%/10% levels

Table 135: Correlations of Environmental Characteristics with Age and Size

Variable	age	agep	focalstaff	focalsales	focalassets	focalmve
i_cns	0.0842	0.1857 ***	0.0721	0.1509 ***	0.1559 ***	0.0648
i_cancer	-0.0556	-0.0637	-0.0893	-0.056	-0.052	-0.075
i_cadiovas	-0.048	-0.0248	-0.0393	-0.0456	-0.0369	-0.0515
i_infectious	0.1494 ***	-0.0685	-0.0507	-0.0284	-0.071	-0.0977 *
i_inflammation	0.0379	0.0872	0.0732	0.115 **	0.1187 **	0.0767
i_metabolic	-0.0011	0.0462	-0.0257	-0.0215	-0.0001	-0.0466
i_other	-0.0085	0.0651	0.0233	0.0764	0.0819	-0.0629
i_respiratory	0.01	0.024	0.009	-0.0129	-0.0252	-0.0106
i_various	-0.0234	-0.0063	0.0146	0.0146	-0.0129	0.0635
ptype_bt	0.0833	0.1123 **	0.1619 ***	0.1596 ***	0.1663 ***	0.1413 **
ptype_oth	-0.0641	-0.0616	-0.0548	-0.0436	-0.0803	-0.0678
ptype_ph	-0.0264	-0.0099	-0.0693	-0.0809	-0.0526	-0.0472
ptype_res	-0.0257	-0.1032 *	-0.108 *	-0.0977 *	-0.1108 **	-0.0891
pregion_eu	-0.0984 *	-0.0399	-0.0738	-0.0353	-0.0238	-0.0609
pregion_j	-0.0429	-0.0167	-0.0215	-0.0373	-0.0565	-0.0209
pregion_oth	0.1224 **	-0.0323	-0.0664	-0.0441	-0.0727	-0.0871
pregion_us	0.0698	0.082	0.1263 **	0.0894	0.0875	0.1333 **
mktactivity	-0.0834	-0.0142	-0.0155	0.0018	0.1036 *	0.0617
mktretsx	0.0375	-0.0103	-0.0207	-0.0479	-0.1057 *	-0.0161
mktretsb	0.0095	0.0124	-0.0754	-0.0599	-0.1075 *	-0.0283
mktretbt	0.0066	0.062	-0.0707	-0.0577	-0.1008 *	-0.0559
mktvolsx	0.0881	0.1859 ***	0.0858	0.0934	0.0764	-0.1005 *
mktvolsb	-0.0251	-0.0403	-0.0397	-0.0016	-0.0004	0.1104 *
mktvolbt	-0.0419	-0.0232	-0.0489	-0.0215	-0.0114	0.0982 *

All figures indicate standard correlation coeffiicients (spearman rank correlations for dummy variables)

***/**/* indicates significance at 1%/5%/10% levels

Table 136: Correlations of Structural Transaction Characteristics with Age and Size

Variable	age	agep	focalstaff	focalsales	focalassets	focalmve
licshort	0.0031	-0.0866	-0.1076 *	-0.107 *	-0.1162 **	-0.1129 **
liclong	0.0752	0.0623	0.1295 **	0.1503 ***	0.1303 **	0.0742
equityshort	-0.0403	0.0673	-0.0728	-0.0718	-0.0476	-0.0329
equitylong	-0.0514	-0.0029	-0.0179	-0.0291	0.0191	-0.0176
optionshort	-0.0883	-0.0557	-0.1059 *	-0.1169 **	-0.0821	-0.1123 **
optionlong	0.0595	0.0768	0.0647	0.0205	0.0676	0.0159
jv	0.0387	0.0109	0.0311	0.0318	-0.0012	0.0471
guarantlong	-0.0507	0.0296	-0.1149 **	-0.1207 **	-0.107 *	-0.1026 *
guarantshort	0.0776	0.1388 **	0.1496 ***	0.1653 ***	0.1719 ***	0.1462 ***
milestonelong	-0.0794	-0.0223	-0.1228 **	-0.1302 **	-0.1163 **	-0.0875
milestoneshort	0.2221 ***	0.2362 ***	0.3122 ***	0.3547 ***	0.3547 ***	0.3346 ***
royaltylong	-0.0988 *	-0.0419	-0.136 **	-0.1238 **	-0.1009 *	-0.0778
royaltyshort	0.1006 *	0.1027 *	0.1805 ***	0.2364 ***	0.2223 ***	0.2483 ***
value	0.0177	0.046	0.0011	0.0203	0.0028	0.0161
valuereport	0.0898	0.1898 ***	0.101 *	0.1254 **	0.125 **	0.1151 **
scope2	0.1631 ***	0.0573	0.138 **	0.1521 ***	0.1346 **	0.0798
time	-0.0424	-0.0419	-0.0951 *	-0.0814	-0.0752	-0.0229
timelimit	-0.0424	-0.0363	-0.0905	-0.087	-0.0776	-0.0281
regional	0.1969 ***	0.1251 **	0.1365 **	0.247 ***	0.165 ***	0.0456

All figures indicate standard correlation coeffiicients (spearman rank correlations for dummy variables)

***/**/* indicates significance at 1%/5%/10% levels

Table 137: Correlations of Age and Size with Partner-Firm and Market Development Variables

Variable	age	agep	focalstaff	focalsales	focalassets	focalmve
pstatus	0.0233	0.058	0.0254	0.0308	0.0558	0.0321
ppstatus	0.0368	0.0895	0.0408	0.0354	0.0628	0.0523
Pp	-0.0568	-0.0518	-0.0794	-0.0259	-0.0181	-0.0851
ppp	0.0613	0.0585	0.0894	0.0693	0.0537	0.0815
pppp	-0.019	-0.016	-0.0082	0.0123	0.0112	-0.0177
ptrans	-0.0356	0.0785	-0.0315	-0.0541	0.0051	0.0081
pptrans	0.0884	0.1134 **	0.1139 **	0.0938	0.1193 **	0.118 **
ppptrans	0.0092	0.1229 **	0.0237	-0.0043	0.06	0.0615

All figures indicate standard correlation coeffiicients
***/**/* indicates significance at 1%/5%/10% levels

Table 138: Correlations among Partner-Firm Characteristics

Variable	ptype_bt	ptype_oth	ptype_ph	ptype_res	pstatus	pp	ptrans
Collaboration Structure (Control 11)							
ptype_bt	1						
ptype_oth	-0.4294 ***	1					
ptype_ph	-0.5868 ***	-0.24 ***	1				
ptype_res	-0.3251 ***	-0.133 **	-0.1817 ***	1			
pstatus	-0.0184	-0.1262 **	0.3941 ***	-0.4017 ***	1		
pp	-0.1743 ***	0.0888	0.1815 ***	-0.079	0.1913 ***	1	
ptrans	-0.2978 ***	-0.1802 ***	0.5993 ***	-0.1572 ***	0.3744 ***	0.1556 ***	1

All figures indicate standard correlation coeffiicients (spearman rank correlations for dummy variables)

***/**/* indicates significance at 1%/5%/10% levels

Multivariate Regression Results

Table 139: Regression Models on Medical Indications (Control 1) and Partner Type (Control 2)

Model	Control 1a	Control 1b	Control 1c	Control 2a	Control 2b	Control 2c
i_cns	0.0082					
i_cancer	0.0236	0.0242	0.0242			
i_cadiovas	-0.0180					
i_infectious	0.0042	0.0048				
i_inflammation	-0.0070					
i_metabolic	0.0035					
i_other	-0.0016					
i_respiratory	-0.0015					
i_various	-0.0069	-0.0064				
ptype_bt				-0.0038	0.0018	
ptype_ph				0.0323	0.0379 **	0.0367 **
ptype_res				-0.0149		
intercept	0.0275 ***	0.0269 ***	0.0268 ***	0.025	0.0194	0.0206 ***
df	318	324	326	324	325	326
R^2	-0.0220	-0.0042	0.0015	0.0108	0.0129	0.0159
F	0.2190	0.5467	1.4835	2.1883	3.1330	6.2715
AIC	-469.14	-480.77	-484.61	-485.70	-487.38	-489.37

***/**/* indicates significance at 1%/5%/10% levels

Table 140: Regression Models on Partner Firm Origin (Control 3)

Model	Control 3a	Control 3b	Control 3c	Control 3d	Control 3e	Control 3f
ptype_ph	0,0386 **	0,0371 **	0,0368 **		0.0346 **	
pregion_us	0,0249	0,0329				
pregion_eu	0,0232	0,0314				
pregion_j	-0,0238					
pregion_main			0,0402 *	0,0401 *	0.0453 **	0.0447 **
focalstafflog					-0.0190 ***	-0.0198 ***
intercept	-0,001	-0,0091	-0,0157	-0,0065	0,0851 **	0,0987 ***
df	323	324	325	326	313	314
R^2	0,0162	0,0182	0,0236	0,0076	0.0550	0.0415
F	2,3486	3,0199	4,9604	3,5193	7.1274	7.8439
AIC	-486,52	-488,16	-490,98	-486,64	-475.40	-471.90

***/**/* indicates significance at 1%/5%/10% levels

Table 141: Regression Models on Capital-Market Climate (Control 4)

Model	Control 4a	Control 4a	Control 4a	Control 4a
focalstafflog	-0.0151 ***	-0.0155 ***	-0.0135 ***	-0.0137 ***
ptype_ph	0.0228	0.0236	0.0004	0.0011
pregion_main	0.0329	0.0318	0.0286	0.0280
equityshort	0.1357 ***	0.1336 ***	0.0494 *	0.0488 *
payin	0.0249 *	0.0255 *	0.0092	0.0096
value			0.0000	-0.0001
valuepayin			0.0014 *	0.0014 *
mktretsx	-0.063 *		-0.0435	
mktretbt		-0.0197 **		-0.0129 *
intercept	0.057	0.0663 *	0.0592 *	0.0651 *
df	310	310	308	308
R^2	0.1277	0.1355	0.2942	0.2971
F	8.7114	9.2556	17.4640	17.6951
AIC	-497.84	-500.69	-563.02	-564.33

***/**/* indicates significance at 1%/5%/10% levels

Table 142: Regression Models on Focal-Firm Size (Control 5)

Model	Control 5a	Control 5b	Control 5c	Control 5d	Control 5e	Control 5f
ptype_ph	0,0328 **	0,0350 **	0,0353 **	0,0352 **	0,0340 **	0,0343 **
focalsales	0,0000 *					
focalassets		0,0000 *				
focalstaff			0,0000 *		-0,0001 **	
focalmve				0,0000 *		
focalstaff2					0,0000 *	
focalstafflog						-0,0185 ***
intercept	0,0272 ***	0,0284 ***	0,0291 ***	0,0280 ***	0,0400 ***	0,1233 ***
df	300	321	314	307	313	314
R^2	0,0217	0,0232	0,0245	0,0224	0,0314	0,0450
F	4,3548	4,8283	4,9614	4,547	4,4142	8,4514
AIC	-449,65	-481,65	-466,31	-449,60	-467,58	-473,07

***/**/* indicates significance at 1%/5%/10% levels

Table 143: Regression Models on Partner-Firm Resources (Control 6)

Model	Control 6a	Control 6b	Control 6c	Control 6d	Control 6e	Control 6f
focalstafflog	-0.0181 ***	-0.0185 ***	-0.0187 ***	-0.0186 ***	-0.0188 ***	-0.019 ***
ptype_ph	0.0287 *	0.0318 **	0.0268 *	0.0304 *	0.0161	0.0219
pp	0.0000					
pppp		0.0000				
pstatus			0.0168			
ppstatus				0.0091		
ptrans					0.0001	
ppptrans						0.0001
intercept	0.1197 ***	0.1224 ***	0.1158 ***	0.1189 ***	0.1220 ***	0.1238 ***
df	313	313	313	313	313	313
R^2	0.0473	0.0436	0.0462	0.0432	0.0498	0.0466
F	6.2290	5.8066	6.0965	5.7514	6.5196	6.1432
AIC	-472.83	-471.62	-472.45	-471.46	-473.66	-472.59

***/**/* indicates significance at 1%/5%/10% levels

Table 143 (Continued)

Model	Control 6g	Control 6h	Control 6i	Control 6j	Control 6k	Control 6l
focalstafflog	-0.0185 ***	-0.019 ***	-0.0186 ***	-0.0193 ***	-0.0191 ***	-0.0187 ***
ptype_ph	0.0094	0.019				
pp	0.0000		0.0000 *			0.0000
pppp		0.0000				
pstatus	0.0110			0.0262 **		0.0124
ppstatus		0.0053				
ptrans	0.0001				0.0002 ***	0.0001 *
ppptrans		0.0001				
intercept	0.1144 ***	0.1205 ***	0.1285 ***	0.1202 ***	0.1254 ***	0.1154 ***
df	311	311	314	314	314	312
R^2	0.0497	0.0420	0.0398	0.0409	0.0506	0.0520
F	4.3030	3.7702	7.5523	7.7337	9.4131	5.3330
AIC	-471.65	-469.10	-471.34	-471.69	-474.91	-473.41

***/**/* indicates significance at 1%/5%/10% levels

Table 144: Regression Models on Focal Firm Alliance Experience (Control 7)

Model	Control 7a	Control 7b	Control 7c	Control 7d	Control 7e	Control 7f
focalstafflog	-0.0196 ***	-0.0181 **	-0.0193 ***	-0.0176 **	-0.0199 ***	-0.0184 ***
ptype_ph	0.034 **	0.0361 **	0.0094	0.0112		
ptrans					0.0002 ***	0.0002 ***
experience	0.0001	-0.0006	0.0001	-0.0006	0.0001	-0.0006
experience2		0.0000		0.0000		0.0000
pp			0.0000	0.0000		
pstatus			0.0108	0.0107		
ptrans			0.0001	0.0001		
intercept	0.1273 ***	0.1279 ***	0.1171 ***	0.1177 ***	0.1282 ***	0.1291 ***
df	313	312	310	309	313	312
R^2	0.0423	0.0419	0.0467	0.0468	0.0477	0.0473
F	5.6473	4.4582	3.5813	3.2168	6.2705	4.92
AIC	-471.16	-470.07	-469.69	-468.75	-472.95	-471.84

***/**/* indicates significance at 1%/5%/10% levels

Table 145: Regression Models on Focal Firm Performance (Control 9)

Model	Control 9a	Control 9b	Control 9c	Control 9d
focalstafflog	-0.0184 ***	-0.0206 ***	-0.0191 ***	-0.0189 ***
ptype_ph	0.0300 *	0.0338 **	0.0333 **	0.0340 **
focalebit	0.0000			
focalocf		0.0000		
focalncf			0.0000	
focalq				0.0003
intercept	0.1248 ***	0.1349 ***	0.1264 ***	0.1250 ***
df	296	308	308	303
R^2	0.0384	0.0418	0.0433	0.0414
F	4.9788	5.5254	5.6866	5.4106
AIC	-432.98	-459.44	-459.91	-447.36

***/**/* indicates significance at 1%/5%/10% levels

Table 146: Regression Models on Prior Relations (Control 8) and Transaction Function (Control 10)

Model	Control 8	Control 10	Control 10	Control 8/ Control 10
focalstafflog	-0.0191 ***	-0.0177 ***	-0.0178 ***	-0.0180 ***
ptype_ph	0.0315 **	0.0345 **	0.0341 **	0.0305 **
pregion_main	0.0446 **	0.0438 **	0.0432 **	0.0424 *
prior	0.0158			-0.0022
f_rnd		0.0084	0.0127	0.0082
f_commercial		-0.0053		
priorrnd				0.0240
intercept	0.0845 **	0.0755 *	0.0725 *	0.0754 *
df	312	311	312	310
R^2	0.0544	0.0516	0.0546	0.0518
F	5.5471	4.441	5.559	3.8784
AIC	-474.23	-472.31	-474.27	-471.39

***/**/* indicates significance at 1%/5%/10% levels

Table 147: Regression Models on Transaction Governance (Control 11)

Model	Control 11a	Control 11b	Control 11c	Control 11d	Control 11e	Control 11f
focalstafflog	-0.0175 ***	-0.0181 ***	-0.0182 ***	-0.0175 ***	-0.0176 ***	-0.0171 ***
ptype_ph	0.0304 **	0.0337 **	0.0349 **	0.0342 **	0.0341 **	0.0335 **
pregion_main	0.0451 **	0.0442 **	0.0417 *	0.0411 *	0.0399 *	0.0396 *
licshort	0.0296 *	0.0293 *		0.0226		0.0207
liclong	-0.0254					
allequity			0.0621 ***	0.0577 ***		
jv					-0.0012	0.0019
equityequity					0.0749 ***	0.0695 ***
intercept	0.0746 **	0.0746 **	0.0765 **	0.0691 *	0.0753 **	0.0686 *
df	311	312	312	311	311	310
R^2	0.0656	0.0631	0.0814	0.0849	0.0844	0.0868
F	5.4383	6.3173	8.0007	6.8668	6.8253	6.0067
AIC	-477.02	-477.14	-483.40	-483.64	-483.45	-483.31

***/**/* indicates significance at 1%/5%/10% levels

Table 148: Regression Models on Financial Payments (Control 12)

Model	Control 12a	Control 12b	Control 12c	Control 12d
focalstafflog	-0.0160 ***	-0.0159 ***	-0.0137 **	-0.0142 **
ptype_ph	0.0260 *	0.0257 *	0.0197	0.0224
pregion_main	0.0368 *	0.0369 *	0.0325	0.0328
equityshort	0.1374 ***	0.1372 ***	0.1276 ***	0.1291
equitylong	0.0052			
payin			0.0244 *	0.0225 *
payout			-0.0135	
intercept	0.0710 **	0.0712 **	0.0584	0.0584
df	311	312	310	311
R^2	0.1138	0.1166	0.1206	0.1216
F	9.1194	11.4275	8.2241	9.7513
AIC	-493.82	-495.79	-495.27	-496.61

***/**/* indicates significance at 1%/5%/10% levels

Table 148 (Continued)

Model	Control 12e	Control 12f	Control 12g	Control 12h	Control 12i
focalstafflog	-0.0159 ***	-0.014 ***	-0.0143 ***	-0.0131 **	-0.0127 **
ptype_ph	0.0190	0.0005	0.0004	-0.0006	-0.0001
pregion_main	0.0295	0.0277	0.0272	0.0285	0.0286
equityshort	0.1078 ***	0.0481 *	0.0463 *	0.0423	0.0441
payin	0.0128	0.0113	0.0099	0.0086	0.0072
payout			-0.0096		
valuereport	0.0517 ***	-0.0096			
value		0.0013 ***	0.0013 ***	-0.0009	-0.0001
valuepayin				0.0022 *	0.0015 **
valuepayout				0.0013	
intercept	0.0686 *	0.0655 **	0.0671 **	0.0628 *	0.0595 *
df	310	309	310	307	309
R^2	0.1396	0.2837	0.2854	0.2899	0.2923
F	9.5434	18.8780	22.0341	15.3332	19.6433
AIC	-502.18	-559.31	-561.05	-560.13	-563.14

***/**/* indicates significance at 1%/5%/10% levels

Table 149: Summary of Findings on Control Hypotheses

Control		Variable(s)	Predicted Effect	Observed Effect
1	Industry/Market Segment	Medical Indication Dummies	sign.	n.s.
2	Partner Relatedness	Downstream: Pharma Partner Horizontal: Biotech Partner Upstream: University Partner	+	+ n.s. n.s.
3	International Aspects	European Transaction Partner North American Trans. Partner Japanese Transaction Partner European/North American Partner	sign.	n.s. n.s. n.s. +
4	Stock-Market Climate	Return on General Market Index Return on Biotech Stock Index	– –	(–) –
5	Firm Size	Focal Firm Market Value Focal Firm Assets Focal Firm Sales Focal Firm Staff	–	–
6	Partner Resources	Partner Firm Patent Endowment Partner Firm Public Status Partner Firm Prior Alliances	+	(+)
7	Alliance Experience	No. of Focal Firm Prior Alliances	+	n.s.
8	Prior Relations	Prior Alliance Dummy	+	n.s.
9	Transaction Function	R&D Commercialization [manufacturing]	+	n.s.
10	Focal Firm Performance	Focal Firm EBIT Focal Firm Operating CF Focal Firm Total CF Focal Firm q	–	n.s.
11	Transaction Governance	License Joint Venture Equity Investment	+ + +	n.s. n.s. +
12	Financial Payments	Equity Investment in Focal Firm Equity Investment in Partner Payments to Focal Firm Payments to Partner Amount of Payments to Focal Firm Amount of Payments to Partner	+ – + – + –	(+) n.s. (+) n.s. + n.s.

sign./n.s: Significant / non-significant evidence
[…]: Base Category
+/–: Positively/negatively significant evidence
(+)/(–): Limited positively/negatively significant evidence

Table 150: Regression Models on Development Stage (Hypothesis 4) and Business Model (Hypothesis 5)

Model	Hypothesis 4a	Hypothesis 5a	Hypothesis 5b	Hypothesis 5c	Hypothesis 5d
focalstafflog	-0,0194 ***	-0,018 ***	-0,0178 ***	-0,0185 ***	-0,0174 ***
ptype_ph	0,0356 **	0,0336 **	0,0339 **	0,0348 **	0,0328 **
pregion_main	0,0471 **	0,0418 *	0,041 *	0,0421 *	0,0419 *
exploitation	0,0084				
m_drug		0,0588	0,0248	0,0301 **	
m_technology		0,0221	-0,0121		-0,0248 *
m_service		0,0351			
m_diag		0,0468			
intercept	0,0823 **	0,0432	0,077 **	0,0741 **	0,0871 **
df	312	309	311	312	312
R^2	0,0531	0,0631	0,066	0,0673	0,0609
F	5,4332	4,0411	5,4671	6,7049	6,1252
AIC	-473,79	-474,22	-477,15	-478,59	-476,41

***/**/* indicates significance at 1%/5%/10% levels

Table 151: Regression Models on Combined Effects of Development Stage and Business Model (Hypotheses 4 and 5)

Model	Hypothesis 4b	Hypothesis 4c	Hypotheses 4/5a	Hypotheses 4/5b	Hypotheses 4/5c	Hypotheses 4/5d
focalstafflog	-0,0177 ***	-0,0182 ***	-0,0179 ***	-0,0197 ***	-0,0200 ***	-0,0198 ***
ptype_ph	0,0363 **	0,0366 **	0,0364 **	0,0344 **	0,0347 **	0,0349 **
pregion_main	0,0461 **	0,0457 **	0,0439 **	0,0396 *	0,0431 *	0,0401 *
f_rnd	0,0251	0,0065	0,0165	0,0135	0,0135	0,0162
exploitation	0,0222	0,001	0,0186	-0,0060	-0,0056	-0,0044
m_drug			0,0270 *	-0,0082	0,0915	0,0032
rndexploit		0,0386				
drugrnd				0,0121	-0,0890	
drugexploit				0,0730 **	-0,0310	0,0661 **
drugexploirnd					0,1110	
intercept	0,0527	0,0711	0,0527	0,0784 *	0,0765 *	0,0761 *

Table 151 (Continued)

Model	Hypothesis 4b	Hypothesis 4c	Hypotheses 4/5a	Hypotheses 4/5b	Hypotheses 4/5c	Hypotheses 4/5d
df	311	310	310	308	307	309
R^2	0,0572	0,0586	0,0658	0,0769	0,0765	0,0797
F	4,8366	4,2765	4,7082	4,2925	3,9076	4,9069
AIC	-474,19	-473,66	-476,09	-477,96	-476,83	-479,86

***/**/* indicates significance at 1%/5%/10% levels

Table 152: Regression Models on Alliance Direction (Hypothesis 6) and Contextual Alliance Characteristics (Hypotheses 4-6)

Model	Hypothesis 6a	Hypothesis 6b	Hypothesis 6c	Combined Hypotheses 4-6a	Combined Hypotheses 4-6b	Combined Hypotheses 4-6c
focalstafflog	-0,0195 ***	-0,0193 ***	-0,0195 ***	-0,0188 ***	-0,0190 ***	-0,0190 ***
ptype_ph	0,0257	0,0255	0,029 *	0,0308 *	0,0304 *	0,0290 *
pregion_main	0,041 *	0,041 *	0,0403 *	0,0404 *	0,0437 **	0,0384 *
f_rnd	0,0221	0,0219	0,0166	0,0179	0,0054	0,0100
exploitation	-0,0043	-0,0042	-0,0045	-0,0035	-0,0179	-0,0157
m_drug	0,0059	0,0047	-0,026	-0,0201	0,0796	0,0780
d_outbound	0,0273	0,0225	-0,0053	-0,0056	-0,0078	-0,0013
d_inbound	0,0084					
drugexploit	0,062 **	0,0636 **	0,052 *	0,0285	-0,0845	-0,0132
drugout			0,0732 ***	0,0578 *	0,0626 *	-0,1853 **
drugrnd					-0,1004	-0,0996
rndexploit					0,0194	0,0167
exploitout						0,0015
rndout						-0,0078
drugexploitout				0,0443	0,0403	0,1819 **
drugexploitrnd					0,1280	-0,0112
drugoutrnd						0,2497 ***
intercept	0,0553	0,0591	0,0785 *	0,0732 *	0,0819 *	0,0832
df	307	308	307	306	302	300
R^2	0,0819	0,0843	0,1034	0,1033	0,0980	0,1242
F	4,1330	4,6373	5,0490	4,6394	3,4521	3,8011
AIC	-478,70	-480,50	-486,21	-485,20	-479,51	-486,96

***/**/* indicates significance at 1%/5%/10% levels

Table 153: Regression Models on Contextual Alliance Characteristics (Hypotheses 4-6)

Model	Combined Hypotheses 4-6e	Combined Hypotheses 4-6f	Combined Hypotheses 4-6g	Combined Hypotheses 4-6h	Combined Hypotheses 4-6i	Combined Hypotheses 4-6j
focalstafflog	-0,0189 ***	-0,0189 ***	-0,0189 ***	-0,0145 ***	-0,0145 ***	-0,0145 ***
ptype_ph	0,0287 *	0,0287 *	0,0287 *	-0,0026	-0,0026	-0,0026
pregion_main	0,0387 *	0,0387 *	0,0387 *	0,0290	0,029	0,029
f_rnd	0,0063	0,0063	0,0063	0,0010	0,0010	0,0010
exploitation	-0,0206	-0,0206	-0,0206	-0,0254	-0,0254	-0,0254
m_drug	0,0753	0,0753	0,0753	0,0600	0,0600	0,0600
d_outbound	-0,0060	-0,006	-0,006	0,0042	0,0042	0,0042
drugexploit	-0,0086	-0,0086	-0,0086	0,0110	0,011	0,011
drugout	-0,2033 *	-0,0061	0,0628 *	-0,1219	-0,0417	0,0367
drugrnd	-0,0961	-0,0961	-0,0961	-0,0752	-0,0752	-0,0752
rndexploit	0,0248	0,0248	0,0248	0,0336	0,0336	0,0336
exploitout	0,0090	0,009	0,009	0,0088	0,0088	0,0088
rndout	-0,0015	-0,0015	-0,0015	0,0002	0,0002	0,0002
drugexploitout	0,1972 **		-0,0689	0,0803		-0,0784
drugexploitrnd	-0,0189	-0,0189	-0,0189	-0,0381	-0,0381	-0,0381
drugoutrnd	0,2661 **	0,0689		0,1587	0,0784	
rndexploitout	-0,0228	-0,0228	-0,0228	-0,0368	-0,0368	-0,0368
exploit4way		0,1972 **	0,2661 **		0,0803	0,1587
equityshort				0,0311	0,0311	0,0311
payin				0,0011	0,0011	0,0011
value				-0,0001	-0,0001	-0,0001
valuepayin				0,0014 *	0,0014 *	0,0014 *
intercept	0,0856	0,0856	0,0856	0,0714	0,0714	0,0714
df	299	299	299	295	295	295
R^2	0,1215	0,1215	0,1215	0,2833	0,2833	0,2833
F	3,5701	3,5701	3,5701	6,9488	69.488	69.488
AIC	-485,03	-485,03	-485,03	-545,85	-545,85	-545,85

***/**/* indicates significance at 1%/5%/10% levels

Table 154: Regression Models on Compensation Structure (Hypothesis 7)

Model	Hypothesis 7a	Hypothesis 7b	Hypothesis 7c	Hypothesis 7d	Hypothesis 7e	Hypothesis 7f
focalstafflog	-0,0162 ***	-0,0145 **	-0,0156 ***	-0,0134 **	-0,0172 ***	-0,0158 ***
ptype_ph	0,0204	0,0145	0,0171	0,0027	0,0267 *	0,0184
pregion_main	0,0367 *	0,0369	0,0365	0,0283	0,0328	0,0334
guarantlong	0,0391 *	0,0911 **	0,0326	0,007	0,0437 **	0,0762 **
guarantshort	-0,0045	-0,0465	-0,0188	-0,0025	-0,0078	-0,0372
milestonelong	0,0107	-0,0328	-0,004	-0,0201	-0,004	-0,0645
milestoneshort	0,0108	-0,0003	-0,0123	0,0161	0,0103	-0,0015
royaltylong	0,0047	0,0048	-0,0002	-0,0218	-0,0073	-0,0328
royaltyshort	-0,0022	-0,0085	-0,0009	-0,0082	0,0053	0,0178
guarmilelong		-0,0545				0,0252
guarmileshort		0,0044				0,0606
guarroyallong		-0,0751				0,0229
guarroyalshort		0,0599				-0,0004
mileroyallong		0,0606				0,1226 **
mileroyalshort		[dropped]				0,0469
all3long		0,0746	0,0367			
all3short		0,0018	0,0431			
equityshort				0,0403		
payin				0,0319		
value				-0,0002		
valuepayin				0,0016 **		
m_drug					0,0724	0,0831
f_rnd					0,0043	0,0016
exploitation					-0,0088	-0,0122
drugexploit					-0,0438	-0,0548
d_outbound					-0,009	-0,0027
drugout					0,0394	0,0307
drugrnd					-0,0826	-0,0885
rndexploit					0,0137	0,022
rndout					-0,0053	-0,0058
exploitout					-0,0104	-0,0119
exploit4way					0,2218 ***	0,2345 ***
intercept	0,0680	0,0601		0,0625	0,0778	0,0723
df	307	300	305	303	296	290
R^2	0,0663	0,0641	0,0655	0,2832	0,1248	0,123
F	3,4930	23.528	3,0149	10,6030	3,2532	2,7045
AIC	-473,35	-465,92	-471,17	-553,31	-483,44	-477,27

***/**/* indicates significance at 1%/5%/10% levels

Table 155: Regression Models on Time-Limited Collaboration (Hypothesis 8)

Model	**Hypothesis 8a**	**Hypothesis 8b**	**Hypothesis 8c**	**Hypothesis 8d**	**Hypothesis 8e**	**Hypothesis 8f**
focalstafflog	-0,0183 ***	-0,0177 ***	-0,0183 ***	-0,0124 **	-0,0121 **	-0,0122 **
ptype_ph	0,0304 **	0,0333 **	0,0351 **	-0,0022	0,0018	0,0034
pregion_main	0,0416 *	0,0438 **	0,0474 **	0,0268	0,0295	0,032 *
timelimit	0,0257	-0,1039 ***	-0,0969 ***	0,0146	-0,0855 ***	-0,0816 ***
time		0,0031 ***	0,0029 ***		0,0024 ***	0,0023 ***
regional			0,0391 **			0,0237
equityshort				0,0432	0,0397	0,0402
payin				0,007	0,0056	0,006
value				-0,0002	-0,0004	-0,0005
valuepayin				0,0015 **	0,0016 **	0,0018 **
intercept	0,0818 **	0,0759 **	0,0696	0,0576 *		
df	312	311	310	308	307	306
R^2	0,058	0,1219	0,1334	0,2919	0,3300	0,3329
F	5,8625	9,7756	9,108	17,285	18,295	16,772
AIC	-475,42	-496,72	-499,92	-562,01	-578,57	-578,99

***/**/* indicates significance at 1%/5%/10% levels

Table 156: Regression Models on Contractual Flexibilities (Hypothesis 9) and Time-Limited Collaboration (Hypothesis 8)

Model	Hypothesis 9a	Hypothesis 9b	Hypothesis 9c	Hypothesis 9d	Hypotheses 8/9a	Hypotheses 8/9b
focalstafflog	-0,0185 ***	-0,019 ***	-0,0128 **	-0,012 **	-0,0176 ***	-0,0122 **
ptype_ph	0,0332 **	0,0346 **	-0,0004	-0,0014	0,03 **	0,0009
pregion_main	0,0442 **	0,0453 **	0,0287	0,0296	0,0429 **	0,029
equityshort			0,0474	0,0413		0,0415
payin			0,0096	0,0088		0,008
value			-0,0002	-0,0002		-0,0004
valuepayin			0,0015 **	0,0015 **		0,0017 **
optionshort	0,0144		-0,0217			
optionlong	-0,002	0,0006	-0,0123	0,0023		
optlongout		-0,0008		-0,0395		
timelimit					-0,1142	-0,0895 ***
time					0,0029 ***	0,0024 ***
optionality					-0,0075	-0,0268 *
timelimitoption					0,098 **	0,0234
intercept	0,0818 **	0,085 **	0,0622 *	0,0552	0,0782	0,059 *
df	311	311	307	307	309	305
R^2	0,0505	0,0489	0,2922	0,2907	0,1307	0,3321
F	4,3614	4,2492	15,494	15,393	7,7866	15,285
AIC	-471,93	-471,40	-561,15	-560,51	-497,95	-577,64

***/**/* indicates significance at 1%/5%/10% levels

Table 157: Regression Models on Market Activity (Hypothesis 10)

Model	**Hypothesis 10a**	**Hypothesis 10b**	**Hypothesis 10c**	**Hypothesis 10d**	**Hypotheses 10e**	**Hypotheses 10f**
focalstafflog	-0,0189 ***	-0,0133 ***	-0,0125 **	-0,0186 ***	-0,0134 ***	-0,0199 ***
ptype_ph	0,0343 **	0,0004	0,0022	0,0298 *	0,0035	0,0281 *
pregion_main	0,0450 **	0,0300	0,0307	0,0385 *	0,0296	0,0372 *
payin		0,0093	0,0075		0,0096	
value		-0,0001	-0,0003		-0,0003	
valuepayin		0,0015 **	0,0017 **		0,0016 **	
timelimit			-0,0858 ***		-0,0871 ***	
time			0,0024 ***		0,0025 ***	
f_rnd				0,0050		0,0062
exploitation				-0,0071		0,0046
m_drug				0,0690		0,0692
d_outbound				-0,0026		0,0051
drugexploit				-0,0365		-0,0446
drugout				0,0452		0,0448
drugrnd				-0,0817		-0,0811
rndexploit				0,0140		0,0089
rndout				0,0019		0,0058
exploitout				-0,0108		-0,0244
exploit4way				0,2070 ***		0,2213 ***
mktactivity	-0,0001	0,0000	0,0000	0,0000	-0,0002	-0,0003
mktretbt					-0,0157 *	-0,0260 ***
intercept					0,1025 *	0,1383 *
df	312	309	307	301	306	300
R^2	0,0523	0,2865	0,3253	0,1242	0,3315	0,1431
F	5,3560	19,1306	17,9320	3,9870	16,671	4,2977
AIC	-473,50	-560,58	-576,37	-487,90	-578,31	-493,87

***/**/* indicates significance at 1%/5%/10% levels

Table 158: Regression Models on Market Volatility (Hypothesis 11)

Model	Hypothesis 11a	Hypothesis 11b	Hypothesis 11c	Hypothesis 11d	Hypothesis 11e	Hypothesis 11f
focalstafflog	-0,0139 ***	-0,0204 ***	-0,0140 ***	-0,0202 ***	-0,0199 ***	-0,0196 ***
ptype_ph	0,0039	0,0282 *	0,0043	0,0287 *	0,0295 *	0,0304 **
pregion_main	0,0299	0,0370 *	0,0309 *	0,0381 *	0,0362 *	0,0377 *
mktretbt	-0,0094	-0,0170 **	-0,0745 **	-0,0601 *	-0,0199	-0,0812 **
mktvolbt	-1,8827	-3,0676 *	-4,4697 **	-4,7910 **	2,15	0,3151
mktretvolbt			3,5865 **	2,3773		3,4286 *
mktretbtout					0,0096	0,0090
mktvolbtout	-6,397				-9,185 ***	-10,300 ***
payin	0,0097		0,0088			
value	-0,0002		-0,0001			
valuepayin	0,0016 **		0,0014 **			
timelimit	-0,0866 ***		-0,0880 ***			
time	0,0024 ***		0,0026 ***			
f_rnd		0,0079		0,0076	0,0102	0,0099
exploitation		0,0018		0,0008	0,0041	0,0024
m_drug		0,0730		0,0748	0,0749	0,0771
d_outbound		0,0047		0,0047	0,1446 **	0,1613 **
drugexploit		-0,0467		-0,0511	-0,0398	-0,0446
drugout		0,0435		0,0438	0,0348	0,0341
drugrnd		-0,0868 *		-0,0883 *	-0,0873 *	-0,0892 *
rndexploit		0,0103		0,0121	0,0063	0,0086
rndout		0,0075		0,0069	0,0125	0,0126
exploitout		-0,0221		-0,0211	-0,0218	-0,02
exploit4way		0,2238 ***		0,2242 ***	0,2208 ***	0,2206 ***
intercept	0,0929 **	0,1360 **	0,1297 ***	0,1597 ***	0,0514	0,0752
df	306	300	305	299	298	297
R^2	0,333	0,1491	0,3405	0,1506	0,1638	0,1699
F	16,776	4,4594	15,829	4,2964	4,439	4,4043
AIC	-579,01	-496,09	-581,62	-495,73	-499,75	-501,14

***/**/* indicates significance at 1%/5%/10% levels

Table 159: Split-Sample Regressions Based on Firm Development (Hypothesis 12) [Alliance Context Models]

Model	3-Way Interactions			4-Way Interaction		
	Full Sample	Large Firms	Small Firms	Full Sample	Large Firms	Small Firms
focalstafflog	-0,0189 ***	-0,0049	-0,0178	-0,0185 ***	-0,0051	-0,0113
ptype_ph	0,0287 *	0,0135	0,0454	0,0298 *	0,0127	0,0462 *
pregion_main	0,0387 *	0,0256	0,0393	0,0384 *	0,0241	0,0373
m_drug	0,0753	0,0789	-0,0376	0,0682	0,0638	0,1418
f_rnd	0,0063	0,0194	0,007	0,0047	0,0214	-0,0027
exploitation	-0,0206	0,0355	-0,0978	-0,0074	0,0303	-0,0743
drugexploit	-0,0086	-0,0868	0.2593 **	-0,0356	-0,0550	-0,0276
d_outbound	-0,0060	0,0186	-0,0173	-0,0032	0,0199	-0,0232
drugout	-0,2033 *	-0,0343	-0.3743 **	0,0451	0,0098	0,0829
drugrnd	-0,0961	-0,0721	[dropped]	-0,0811	-0,0622	-0,1671
rndexploit	0,0248	-0,0022	0,0704	0,0138	-0,0001	0,0555
rndout	-0,0015	0,0007	-0,0206	0,0022	-0,0062	-0,0019
exploitout	0,0090	-0,0474	0,0874	-0,0101	-0,0419	0,0578
drugoutrnd	0,2661 **	0,0309	0.4840 ***			
drugexploitrnd	-0,0189	0,0281	-0.2732 **			
rndexploitout	-0,0228	-0,0056	[dropped]			
drugexploitout	0,1972 **	0,0678	0.2973 **			
exploit4way				0,2059 ***	0,0514	0,3422 **
Intercept	0,0856	-0,012	0,0884	0,0818	-0,0088	0,0631
df	299	140	143	302	143	144
R^2	0,1215	-0,065	0,239	0,1270	-0,0460	0,2345
F	3,5701	0,4362	4,3088	4,2829	0,5063	4,4571
AIC	-485,03	-356,06	-189,56	-489,86	-361,55	-189,51

***/**/* indicates significance at 1%/5%/10% levels

Table 160: Split-Sample Regressions Based on Firm Development (Hypothesis 12) [Compensation Structure and Contractual Features]

Model	Compensation Structure			Contractual Features		
	Full Sample	Large Firms	Small Firms	Full Sample	Large Firms	Small Firms
focalstafflog	-0.0146 **	-0,0015	-0,0415 *	-0.0122 **	-0,0038	-0,0165
ptype_ph	0.0145	0,0089	0,0234	0.0009	0,0106	-0,0061
pregion_main	0.0368	0,0147	0,0619	0.0290	0,012	0,039
guarantlong	0.0826 **	0,0298	0,1212 **			
guarantshort	-0.0481	0,0457	-0,1605			
milestonelong	-0.0699	-0,0572	0,0029			
milestoneshort	-0.0095	-0,1147	0,1307			
royaltylong	-0.0047	0,0207	-0,0439			
royaltyshort	-0.0006	0,0045	0,0328			
guarmilelong	-0.0019	0,0254	-0,0795			
guarmileshort	0.0150	0,0025	[drop]			
guarroyallong	-0.0539	-0,0631	-0,02			
guarroyalshort	0.0534	-0,0544	0,137			
mileroyallong	0.1144 **	0,0765	0,1			
mileroyalshort	0.0012	0,0892	-0,0813			
equityshort				0.0415	0,0242	0,0262
payin				0.0080	0,0111	0,0198
value				-0.0004	-0,0005	0.0113 **
valuepayin				0.0017 **	0,0007	-0.0097 *
timelimit				-0.0895 ***	-0,0226	-0.1056 ***
time				0.0024 ***	0,0003	0.0034 ***
optionality				-0.0268 *	-0,0041	-0,0383
timelimitoption				0.0234	-0,0125	-0,0141
intercept	0.0611	0,002	0,1528	0.0590 *	0,0188	0,0669
df	301	142	144	305	146	147
R^2	0.0659	-0,0369	0,0539	0.3321	-0,0352	0,4599
F	2.4858	0,6273	1,6435	15.285	0,5148	13,229
AIC	-467.47	-362,05	-155,84	-577.64	-365,92	-247,67

***/**/* indicates significance at 1%/5%/10% levels

Table 161: Split-Sample Regressions Based on Firm Development (Hypothesis 12) [Environmental Munificence and Uncertainty]

Model	Main Effects			Interactions		
	Full Sample	Large Firms	Small Firms	Full Sample	Large Firms	Small Firms
focalstafflog	-0,0148 ***	-0,0085	-0,0131	-0.0152 ***	-0,0088	-0,0214
ptype_ph	0,0026	0,0093	-0,0065	-0.0004	0,0123	-0,0286
pregion_main	0,0301	0,0078	0,0442	0.0320 *	0,0089	0,0503
payin	0,0108	0,0151	0,0191	0.0071	0,0158	0,006
value	0,0001	-0,0002	0,0112 *	0.0002	-0,0003	0,0116 **
valuepayin	0,0013 *	0,0004	-0,0095 *	0.0011	0,0005	-0,0099 *
mktretbt	-0,0547 *	-0,0802 **	-0,0042	-0.0755 **	-0,0784 **	-0,0503
mktvolbt	-3,8035 *	-4,6369 *	-2,6068	-0.2182	-2,4408	3,7141
mktretvolbt	2,5242	4,1186 **	0,0142	3.3462 *	5,1199 **	1,2089
d_outbound				0.1296 ***	0,0628	0,231 ***
mktretbtout				0.0115	-0,0223	0,0382
mktvolbtout				-7.5279 **	-4,3773	-12,171 **
intercept	0,1268 ***	0,1198 *	0,0858	0.0672	0,0907	0,0101
df	307	148	149	304	145	146
R^2	0,2965	0,0111	0,3862	0.3063	0,0074	0,4194
F	15,7984	1,1952	12,0463	12.6255	1,0981	10,5127
AIC	-563,10	-374,99	-229,20	-564.64	-371,65	-235,29

***/**/* indicates significance at 1%/5%/10% levels

Robustness Tests and Refined Regression Results

Table 162: Results of Breusch-Pagan and Szroeter Tests for Heteroskedasticity

Model	Controls 2, 3, 5	Controls 11-12	Hypotheses 4-6	Hypothesis 7	Hypotheses 8-9	Hypotheses 10-11
Breusch-Pagan Test	139.91 ***	312.78 ***	533.25 ***	539.94 ***	344.43 ***	294.16 ***
Szroeter Test						
focalstafflog	98.43 ***	26.46 ***	64.88 ***	80.90 ***	25.13 ***	19.89 ***
ptype_ph	30.79 ***	1.41	13.55 ***	26.25 ***	2.69	1.28
pregion_main	9.50 ***	7.52 ***	9.32 ***	8.25 ***	7.09 ***	5.86 **
equityshort		178.93 ***		540.00 ***	66.55 ***	
payin		38.69 ***		61.64 ***	22.64 ***	38.22 ***
value		151.08 ***			104.03 ***	149.76 ***
valuepayin		215.46 ***			145.01 ***	211.82 ***
d_outbound			27.54 ***			10.31 ***
m_drug			65.07 ***			
f_rnd			6.14 **			
exploitation			26.66 ***			
drugexploit			137.63 ***			
drugout			224.94 ***			
drugrnd			57.07 ***			
rndexploit			83.95 ***			
rndout			70.07 ***			
exploitout			47.70 ***			
exploit4way			517.61 ***			
guarantlong				117.04 ***		
guarantshort				3.41 *		
milestonelong				49.30 ***		
milestoneshort				3.94 **		
royaltylong				45.56 ***		
royaltyshort				11.77 ***		
guarmilelong				68.30 ***		
guarmileshort				2.01		
guarroyallong				100.28 ***		
guarroyalshort				2.76 *		

Table 162 (Continued)

Model	Controls 2, 3, 5	Controls 11-12	Hypotheses 4-6	Hypothesis 7	Hypotheses 8-9	Hypotheses 10-11
mileroyallong				69.25 ***		
mileroyalshort				3.08 *		
timelimit					9.28 ***	
time					14.48 ***	
optionality					0.86	
timelimitoption					21.90 ***	
mktretbt		0.14				0.38
mktvolbt						8.69 ***
mktretvolbt						0.72
mktretbtout						0.78
mktvolbtout						0.20

***/**/* indicates significance at 1%/5%/10% levels
All figures are chi2 values

Table 163: Estimation Results Using Heteroskedasticity-Consistent Estimators

Variable	Base Model		Transaction Context (Main Effects)		Compensation Structure	
	Standard	White SE	Standard	White SE	Standard	White SE
focalstafflog	-0.019 ***	-0.019 ***	-0,0174 ***	-0,0174 **	-0.0125 **	-0.0125 **
ptype_ph	0.0346 **	0.0346 *	0,0262 *	0,0262	0.0089	0.0089
pregion_main	0.0453 **	0.0453 ***	0,0447 **	0,0447 ***	0.0294	0.0294 **
m_drug			0,0277 **	0,0277 *		
f_rnd			0,0226	0,0226		
exploitation			0,0179	0,0179		
d_outbound			0,0243 *	0,0243 *		
equityshort					0.1262 ***	0.1262
payin					0.0672	0.0672
guarantlong					-0.0009	-0.0009
guarantshort					-0.0382	-0.0382
milestonelong					-0.0987	-0.0987
milestoneshort					-0.0641	-0.0641
royaltylong					-0.0793	-0.0793

Table 163 (Continued)

Variable	Base Model		Transaction Context (Main Effects)		Compensation Structure	
	Standard	White SE	Standard	White SE	Standard	White SE
royaltyshort					0.0088	0.0088
guarmilelong					0.0252	0.0252
guarmileshort					0.0606	0.0606
guarroyallong					0.0229	0.0229
guarroyalshort					-0.0004	-0.0004
mileroyallong					0.1226 **	0.1226
mileroyalshort					0.0469	0.0469
intercept	0.0851 **	0.0851 **	0,0353	0,0353	0.0546	0.0546 *
df	313	313	309	309	299	299
R^2	0.0550	0.0550	0,0717	0,0717	0.1136	0.1136
F	7.1274	4.7386	4,4846	3,1346	3.3814	3.8618
AIC	-475.40	-475.40	-477,12	-477,12	-482.19	-482.19

Variable	Combined Model		Large Firm Subsample		Small Firm Subsample	
	Standard	White SE	Standard	White SE	Standard	White SE
focalstafflog	-0.0140 ***	-0.0140 **	-0,0075	-0,0075	-0,0251	-0,0251
ptype_ph	0.0008	0.0008	0,0135	0,0135	-0,0083	-0,0083
pregion_main	0.0295	0.0295 **	0,0238	0,0238	0,0353	0,0353 *
equityshort	0.0318	0.0318	0,0237	0,0237	0,001	0,001
payin	0.0009	0.0009	0,0051	0,0051	0,0097	0,0097
value	0.0000	0.0000	-0,0003	-0,0003	0,0183 ***	0,0183 ***
valuepayin	0.0011	0.0011 *	0,0005	0,0005	-0,0171 ***	-0,0171 ***
timelimit	-0.0862 ***	-0.0862 *	-0,0202	-0,0202	-0,1318 ***	-0,1318 **
time	0.0024 ***	0.0024 *	0,0003	0,0003	0,0041 ***	0,0041 **
optionality	-0.0349 **	-0.0349 **	-0,0228	-0,0228	-0,0388	-0,0388 *
timelimitoption	0.0375	0.0375	-0,015	-0,015	0,0345	0,0345
mktretbt	-0.0893 ***	-0.0893 **	-0,0897 **	-0,0897 **	-0,0474	-0,0474
mktvolbt	-1.6124	-1.6124	-3,059	-3,059	0,499	0,499
mktretvolbt	4.1994 **	4.1994 **	4,4989 **	4,4989 *	2,4018	2,4018

Table 163 (Continued)

Variable	Combined Model		Large Firm Subsample		Small Firm Subsample	
	Standard	White SE	Standard	White SE	Standard	White SE
mktvolbtout	-6.0385 **	-6.0385 **	-3,8985	-3,8985	-6,9949	-6,9949 *
d_outbound	0.1108 **	0.1108 **	0,0849	0,0849	0,1129	0,1129 *
m_drug	0.0603	0.0603 *	0,0841 *	0,0841 **	-0,0319	-0,0319
f_rnd	0.0101	0.0101	0,0255	0,0255	0,0153	0,0153
exploitation	-0.0029	-0.0029	0,0326	0,0326	-0,1135 *	-0,1135 *
drugexploit	-0.0523	-0.0523 **	-0,085 *	-0,085 ***	-0,0073	-0,0073
drugout	0.0250	0.0250	0,0028	0,0028	0,1019 **	0,1019 **
drugrnd	-0.0652	-0.0652 *	-0,0715	-0,0715 ***	-0,0087	-0,0087
rndexploit	0.0163	0.0163	0,0102	0,0102	0,0711	0,0711
rndout	-0.0015	-0.0015	-0,0028	-0,0028	-0,0346	-0,0346
exploitout	-0.0174	-0.0174	-0,0408	-0,0408 *	0,1172	0,1172
exploit4way	0.1047 *	0.1047 *	0,0599	0,0599 *	0,0107	0,0107
intercept	0.0824	0.0824	0,0494	0,0494	0,1126	0,1126
df	290	290	131	131	132	132
R^2	0.3556	0.3556	-0,0473	-0,0473	0,5049	0,5049
F	7.7066	2.8085	0,7271	3,6004	7,1967	71,960
AIC	-574.96	-574.96	-351,21	-351,21	-248,62	-248,62

***/**/* indicates significance at 1%/5%/10% levels

Table 164: Variance Inflation Factors for Combined-Effects Model

Variable	Full Model		Main Effects	
	VIF	1/VIF	VIF	1/VIF
focalstafflog	1,20	0,8318	1,12	0,8958
ptype_ph	1,36	0,7367	1,29	0,7759
pregion_main	1,08	0,9242	1,06	0,9401
f_rnd	6,67	0,1499	1,83	0,5479
m_drug	20,14	0,0496	1,19	0,8426
exploitation	7,95	0,1257	1,58	0,6326
d_outbound	27,79	0,0360	1,49	0,6730
drugexploit	6,70	0,1492	---	---
drugout	3,18	0,3143	---	---
drugrnd	14,45	0,0692	---	---
rndexploit	4,13	0,2419	---	---
rndout	8,12	0,1232	---	---
exploitout	7,74	0,1292	---	---
exploit4way	3,42	0,2921	---	---
equityshort	1,35	0,7428	1,25	0,7976
payin	1,36	0,7358	1,34	0,7487
value	31,98	0,0313	1,34	0,7439
valuepayin	32,77	0,0305	---	---
timelimit	3,83	0,2608	3,55	0,2816
time	3,72	0,2690	3,49	0,2866
optionality	1,34	0,7443	1,12	0,8953
timelimitoption	1,59	0,6300	---	---
mktretbt	22,03	0,0454	1,16	0,8623
mktvolbt	3,14	0,3188	1,12	0,8898
mktretvolbt	25,21	0,0397	---	---
mktvolbtout	23,11	0,0433	---	---
Mean VIF	10,21	0,0979	1,59	0,6289

Table 165: Analysis of Outliers and Influential Observations

No.	Company	Cook's Distance	SavgDis	Comment
156	Medigene	0,0273	2,4943	
438	Alizyme	0,0717	-3,3525	March 2000 downgrades
512	Antisoma	2,0743	6,7189	Huge Deal
712	Cambridge Antibody	0,7594	6,3144	Huge Deal
1468	Transgene	0,0132	2,0547	
1526	Vernalis	0,0421	-2,9808	
1657	Bavarian Nordic	0,0955	5,3323	Smallpox Vaccine Deal
1935	Cenes	0,0172	2,7847	
2125	deCODE Genetics	0,0090	2,6500	
2129	deCODE Genetics	0,0294	3,6691	Close to confounding event
2478	GPC Biotech	0,0148	-2,2199	
3616	Medigene	0,0042	2,1422	
3639	Medigene	0,0114	-2,0655	
3679	Qiagen	0,0252	-4,0208	
3742	Actelion	0,2185	-3,8770	
3790	LION Bioscience	0,0094	-2,3862	
3946	Provalis	0,0085	2,0318	
4131	Powderject	0,1101	-2,6587	

Table 166: Estimation Results Excluding Outliers

Variable	Base Model 1 (Controls 1-3)						Base Model 2 (Controls 1-12)					
	Entire Sample			Excluding Outliers			Entire Sample			Excluding Outliers		
	Coef.	Sig[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]
focalstafflog	-0,019	***	***	-0,0124	***	***	-0,0148	***	***	-0,0112	***	***
ptype_ph	0,0346	**	*	0,0255	***	**	-0,0034			0,0173	*	*
pregion_main	0,0453	**	***	0,0359	***	***	0,0314		**	0,0309	**	***
d_outbound							0,0141			-0,0016		
payin							0,0082			0,0046		
value							0,0001			-0,0002		
valuepayin							0,0013	*	**	0,0008		*
mktretbt							-0,0128	*		-0,0071		
intercept	0,0851	**	**	0,0525	**	***	0,0641	*	**	0,0487	**	**
df	313			305			308			300		
R^2	0,055			0,0749			0,293			0,1236		
F	7,1274			9,3119			17,369			6,4278		
AIC	-475,40			-771,32			-562,48			-783,12		

Variable	Alliance Characteristics (Hypotheses 4-6)						Compensation Structure (Hypothesis 7)					
	Entire Sample			Excluding Outliers			Entire Sample			Excluding Outliers		
	Coef.	Sig[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]
focalstafflog	-0.0185	***		-0.0123	***	***	-0.0125	**	**	-0.0098	***	***
ptype_ph	0.0298	*		0.027	***	***	0.0089			0.014		
pregion_main	0.0384	*		0.0326	**	**	0.0294		**	0.0319	**	***
d_outbound	-0.0032			-0.0026								
m_drug	0.0682		**	0.0587	*	**						
f_rnd	0.0047			0.0154								
exploitation	-0.0074			-0.0057								
drugexploit	-0.0356			-0.0334								
drugout	0.0451			0.0148								
drugrnd	-0.0811		**	-0.0768	**	***						
rndexploit	0.0138			0.0049								

Table 166 (Continued)

Variable	Alliance Characteristics (Hypotheses 4-6)						Compensation Structure (Hypothesis 7)					
	Entire Sample			Excluding Outliers			Entire Sample			Excluding Outliers		
	Coef.	Sig[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]
rndout	0.0022			-0.0038								
exploitout	-0.0101			-0.0101								
exploit4way	0.2059	***		0.1091	**	**						
equityshort							0.1262	***		0.019		
payin							0.0672			0.0146		
guarantlong							-0.0009			0.0149		
guarantshort							-0.0382			-0.0373		
milestonelong							-0.0987			-0.0495		
milestoneshort							-0.0641			-0.043		
royaltylong							-0.0793			-0.0171		
royaltyshort							0.0088			-0.0005		
guarmilelong							0.0252			0.0193		
guarmileshort							0.0606			0.0344		
guarroyallong							0.0229			-0.0313		
guarroyalshort							-0.0004			0.0316		
mileroyallong							0.1226	**		0.082	**	*
mileroyalshort							0.0469			0.0255		
intercept	0.0818		*	0.0509		*	0.0546			0.0404	*	**
df	302			294			299			291		
R^2	0.1270			0.0994			0.1136			0,0779		
F	4.2829			3.4277			3.3814			2,5311		
AIC	-489.86			-768.96			-482.19			-758,85		

a/b significance level for standard/White's heteroskedasticity-consistent estimators
***/**/* indicates significance at 1%/5%/10% levels (standard)

Table 166 (Continued)

Variable	Contractual Provisions (Hypotheses 8-9)						Market Dynamics (Hypotheses 10-11)					
	Entire Sample			Excluding Outliers			Entire Sample			Excluding Outliers		
	Coef.	Sig[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]	Coef.	Sig.[a]	Wh[b]
focalstafflog	-0.0122	**	**	-0.0109	***	***	-0.0152	***	***	-0.0108	***	***
ptype_ph	0.0009			0.0175	*	*	-0.0004			0.0204	**	**
pregion_main	0.0290		**	0.0329	**	***	0.0320	*	**	0.0317	**	***
equityshort	0.0415			0.0015								
payin	0.0080			0.004			0.0071			0.006		
value	-0.0004			-0.0002			0.0002			-0.0002		
valuepayin	0.0017	**	**	0.0009	*	**	0.0011		*	0.0007		*
timelimit	-0.0895	***	**	-0.0298								
time	0.0024	***	*	0.0006								
optionality	-0.0268	*	*	-0.0103								
timelimitoption	0.0234			-0.0052								
d_outbound							0.1296	***	***	0.1115	***	***
mktretbt							-0.0755	**		-0.038		
mktvolbt							-0.2182			1.4073		
mktretvolbt							3.3462	*		1.9773		
mktretbtout							0.0115			-0.0008		
mktvolbtout							-7.5279	**	**	-7.3816	***	***
intercept	0.0590	*	*	0.0475	**	**	0.0672			0.0238		
df	305			297			304			296		
R^2	0.3321			0.1181			0.3063			0.1561		
F	15.2852			4.7483			12.6255			5.7488		
AIC	-577.64			-778.30			-564.64			-790.97		

a/b significance level for standard/White's heteroskedasticity-consistent estimators
***/**/* indicates significance at 1%/5%/10% levels (standard)

Table 166 (Continued)

Variable	Entire Sample						Large-Firm Subsample						Small-Firm Subsample					
	Entire Sample			Excl. Outliers			Entire Sample			Excl. Outliers			Entire Sample			Excl. Outliers		
	Coef.	Sig[a]	Wh[b]	Coef.	Sig[a]	Wh[b]	Coef.	Sig[a]	Wh[b]	Coef.	Sig[a]	Wh[b]	Coef.	Sig[a]	Wh[b]	Coef.	Sig[a]	Wh[b]
focalstafflog	-0.0140	***	**	-0,0112	***	***	-0,0075			-0,0014			-0,0251			-0,0277	**	**
ptype_ph	0.0008			0,0216	**	**	0,0135			0,0165			-0,0083			0,0296	*	
pregion_main	0.0295		**	0,0311	**	***	0,0238			0,0235			0,0353		*	0,0434	**	**
m_drug	0.1108	**	**	0,0645	*	**	0,0841	*	**	0,088	**	***	-0,0319			-0,0251		
f_rnd	0.0603		*	0,0175			0,0255			0,044	*	***	0,0153			0,0148		
exploitation	0.0101			-0,0024			0,0326			0,0138			-0,1135	*	*	-0,0446		
d_outbound	-0.0029			0,1211	***	***	0,0849			0,1195	**	**	0,1129		*	0,1054	*	*
drugexploit	-0.0523		**	-0,0393		*	-0,085	*	***	-0,0764	**	***	-0,0073			-0,0074		
drugout	0.0250			0,0016			0,0028			-0,0065			0,1019	**	**	0,0357		
drugrnd	-0.0652		*	-0,0788	**	***	-0,0715		***	-0,0784	**	***	-0,0087			-0,0125		
rndexploit	0.0163			0,005			0,0102			0,0158			0,0711			0,0079		
rndout	-0.0015			0,0072			-0,0028			-0,0138			-0,0346			-0,01		
exploitout	-0.0174			-0,0114			-0,0408		*	-0,0285			0,1172			0,0486		
exploit4way	0.1047	*	*	0,0939	**	**	0,0599		*	0,0561		*	0,0107			0,1104		
equityshort	0.0318			-0,0024			0,0237			0,0241			0,001			0,0045		
payin	0.0009			0,0049			0,0051			-0,0034			0,0097			0,0106		
value	0.0000			-0,0001			-0,0003			-0,0005		*	0,0183	***	***	0,015	***	***
valuepayin	0.0011		*	0,0006			0,0005			0,0014	*	**	-0,0171	***	***	-0,0147	***	***
timelimit	-0.0862	***	*	-0,0208			-0,0202			-0,025			-0,1318	***	**	-0,0489		*
time	0.0024	***	*	0,0003			0,0003			0,0004			0,0041	***	**	0,0013	*	*
optionality	-0.0349	**	**	-0,013			-0,0228			-0,0199			-0,0388		*	-0,0129		
timelimitoption	0.0375			-0,0053			-0,015			-0,0232			0,0345			0,0036		
mktretbt	-0.0893	***	**	-0,04	*		-0,0897	**	**	-0,0669	**	*	-0,0474			-0,0039		
mktvolbt	-1.6124			1,2384			-3,059			-0,7712			0,499			2,4396		
mktretvolbt	4.1994	**	**	1,944			4,4989	**	*	3,423	*	*	2,4018			0,2339		
mktvolbtout	-6.0385	**	**	-7,8204	***	***	-3,8985			-5,7787	*		-6,9949		*	-7,8568	***	***
intercept	0.0824			0,0236			0,0494			-0,0292			0,1126			0,0853		
df	290			282			131			128			132			127		
R^2	0.3556			0,1732			-0,0473			0,0317			0,5049			0,2357		
F	7.7066			3,482			0,7271			1,1937			7,1967			2,8146		
AIC	-574.96			-784,27			-351,21			-408,57			-248,62			-361,41		

a/b Significance for standard OLS regression/White's Heteroskedasticity-Consistent Estimators
***/**/* indicates significance at 1%/5%/10% levels

Table 167: Panel Data Regressions on Control Models

Variable	Basic Controls			Advanced Controls		
	OLS	Fixed Effects	Random Effects	OLS	Fixed Effects	Random Effects
focalstafflog	-0,019 ***	-0,0156	-0,0161 *	-0,0148 ***	-0,0135	-0,0138 *
ptype_ph	0,0346 **	0,0513 ***	0,0448 ***	-0,0034	0,0075	0,001
pregion_main	0,0453 **	0,0382	0,0399 *	0,0314	0,027	0,0278
d_outbound				0,0141	0,0162	0,0175
payin				0,0082	0,0093	0,0078
value				0,0001	0,0003	0,0002
valuepayin				0,0013 *	0,001	0,0012
mktretbt				-0,0128 *	-0,0114	-0,0147 **
intercept	0,0851 **	0,0686	0,0731	0,0641 *	0,0571	0,0615
df	313	270		308	265	
R^2	0,055	-0,1122		0,293	0,1578	
F	7,1274	4,706		17,369	13,7732	
AIC	-475,40	-559,61		-562,48	-643,67	

***/**/* indicates significance at 1%/5%/10% levels

Table 168: Random-Effects Panel Regression Results Using Heteroskedasticity-Consistent Estimation

Variable	Alliance Characteristics		Compensation Structure		Contractual Provisions		Market Dynamics		Combined Effects	
	OLS	RE	OLS	RE	OLS		OLS	RE	OLS	RE
focalstafflog	-0.0185	-0.0186 ***	-0.0125 **	-0.0125 *	-0.0122 **	-0.0124 **	-0.0152 ***	-0.0154 ***	-0,014 ***	-0.014 **
ptype_ph	0.0298	0.0295 *	0.0089	0.009	0.0009	0.0011	-0.0004	-0.0004	0,0008	0.0009
pregion_main	0.0384	0.0394 ***	0.0294 **	0.0291 ***	0.0290 **	0.0286 ***	0.0320 **	0.0306 ***	0,0295	0.0289 ***
d_outbound	-0.0032	-0.0059					0.1296 ***	0.1283 **	0,1108 **	0.1109 ***
m_drug	0.0682 **	0.0681 **							0,0603	0.06 *
f_rnd	0.0047	0.0024							0,0101	0.0117
exploitation	-0.0074	-0.0096							-0,0029	-0.0014
drugexploit	-0.0356	-0.0345							-0,0523	-0.0533 **
drugout	0.0451	0.0453 *							0,025	0.0254
drugrnd	-0.0811 **	-0.0806 ***							-0,0652	-0.0655 **
rndexploit	0.0138	0.0163							0,0163	0.0147
rndout	0.0022	0.0043							-0,0015	-0.0034

Table 168 (Continued)

Variable	Alliance Characteristics		Compensation Structure		Contractual Provisions		Market Dynamics		Combined Effects	
	OLS	RE	OLS	RE	OLS		OLS	RE	OLS	RE
exploitout	-0.0101	-0.0072							-0,0174	-0.0193
exploit4way	0.2059	0.2037							0,1047 *	0.1067 *
equityshort			0.1262	0.1255	0.0415	0.0397			0,0318	0.031
payin			0.0672	0.0671	0.0080	0.0082	0.0071	0.0065	0,0009	0.0009
value					-0.0004	-0.0004	0.0002	0.0003	0	0
valuepayin					0.0017 **	0.0017 **	0.0011 *	0.0011 *	0,0011	0.0011 *
guarantlong			-0.0009	0.0735						
guarantshort			-0.0382	-0.0375						
milestonelong			-0.0987	-0.0976						
milestoneshort			-0.0641	-0.0678						
royaltylong			-0.0793	-0.0801						
royaltyshort			0.0088	0.0096						
guarmilelong			0.0252	0.0241						
guarmileshort			0.0606	0.0621						
guarroyallong			0.0229	0.024						
guarroyalshort			-0.0004	-0.0023						
mileroyallong			0.1226	0.1232						
mileroyalshort			0.0469	0.0493						
timelimit					-0.0895 **	-0.0915 **			-0,0862 ***	-0.0868 *
time					0.0024 *	0.0024 *			0,0024 ***	0.0024 *
optionality					-0.0268 *	-0.0267 **			-0,0349 **	-0.0349 ***
timelimitoption					0.0234	0.024			0,0375	0.0386
mktretbt							-0.0755	-0.0765	-0,0893 ***	-0.0893 **
mktvolbt							-0.2182	-0.4168	-1,6124	-1.7052
mktretvolbt							3.3462	3.3086	4,1994 **	4.1885 **
mktretbtout							0.0115	0.0133		
mktvolbtout							-7.5279 **	-7.388 **	-6,0385 **	-5.9498 **
intercept	0.0818 *	0.0834 *	0.0546 *	0.0548	0.0590 *	0.0603 *	0,0672	0.0733	0,0824	
df	302	303	299	300	305	36	304	305	290	291
R^2 / Chi^2	0.1270	92.2535	0.1136	95.9477	0.3321	31.0204	0,3063	38.3238	0,3556	39,876
F	4.2829		3.3814		15.2852		12,626		7,7066	
AIC	-489.86		-482.19		-577.64		-564,64		-574,96	

***/**/* indicates significance at 1%/5%/10% levels

Table 169: Results of Panel-Data Regressions Excluding Outliers

Variable	Entire Sample		Excluding Outliers	
	Fixed Effects	**Random Effects**	**Fixed Effects**	**Random Effects**
focalstafflog	-0.0126	-0.0136 **	-0,0124	-0,0113 ***
ptype_ph	0.0123	0.0040	0,031 ***	0,0218 **
Pregion_main	0.0237	0.0246	0,0236	0,0305 **
d_outbound	0.0687	0.0624	0,1226 ***	0,1227 ***
m_drug	0.0498	0.0271	0,0816 **	0,0652 *
f_rnd	0.0539	0.0152	0,0344	0,0187
exploitation	0.0935	0.1098 **	0,0103	-0,0018
drugexploit	-0.0875 *	-0.0655	-0,0488	-0,0397
drugout	0.0383	0.0291	-0,0072	0,0006
drugrnd	-0.0809 *	-0.0715	-0,0909 ***	-0,0794 **
rndexploit	-0.0299	0.0010	-0,011	0,0039
rndout	-0.0348	-0.0177	-0,0016	0,0063
exploitout	-0.0665 *	-0.0366	-0,0269	-0,0128
exploit4way	0.1494 **	0.1233 **	0,0979 *	0,0952 **
equityshort	0.0170	0.0245	0,0088	-0,0023
payin	0.0002	0.0006	0,007	0,005
value	0.0002	0.0001	0,0001	-0,0001
valuepayin	0.0008	0.0011	0,0003	0,0006
timelimit	-0.0928 ***	-0.0900 ***	-0,0143	-0,0208
time	0.0025 ***	0.0025 ***	0,0002	0,0003
optionality	-0.0309 *	-0.0340 **	-0,0099	-0,013
timelimitoption	0.0503	0.0463	0,0096	-0,0036
mktretbt	-0.0690 **	-0.0874 ***	-0,0562 **	-0,0404 *
mktvolbt	-4.3711 *	-2.6135	0,3024	1,2503
mktretvolbt	3.2465 *	4.0475 **	2,5251 *	1,9372
mktvolbtout	-3.0389	-5.0315 *	-6,8943 ***	-7,8225 ***
intercept	0.0854	0.0871	0,0296	0,0239
df	247	289	240	282
R^2 / R	0.2358	0.4059 [c]	0,0417	
F / Chi^2	6.4043	192.94 [c]	3,1314	
AIC	-660.80		-842,35	

***/**/* indicates significance at 1%/5%/10% levels

Table 170: Results of Reduced Selection Model Estimation (Cox Proportional Hazard)

Variable	Main Effects		Interaction Effects		Country/Year Controls	
	Standard	Clustered	Standard	Clustered	Standard	Clustered
agep	0.9996 ***	0.9996 ***	0.9987 ***	0.9988 ***	0.9989 **	0.9988 ***
focalstaff	1.0003 ***	1.2572 ***	1.0000	1.0703	1.0002	1.0669
priortrans	1.0100 ***	1.0076	1.0373 ***	1.0355 ***	1.0231 ***	1.0199 **
focalp5	1.0013	1.0010	1.0057 ***	1.0053 ***	1.0037 **	1.0033
focalncf	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
focalq	1.0255	1.0296	1.0500 ***	1.0495 **	1.0268	1.0267
mktactivity	1.0062 **	1.0053	1.0073 **	1.0071 **	1.0037	1.0038
mktretbt	0.7947 **	0.8002 **	0.4071 ***	0.4013 ***	0.2532 ***	0.2617 ***
mktvolbt	3.6011×10^{5}	1.05×10^{7}	0.0000	0.0000	0.0000	0.0000
agestaff			1.0001	1.0001 ***	1.0001	1.0001 ***
priorp5			0.9999 ***	0.9999 ***	0.9999 ***	0.9999 **
mktretvolbt			1.16×10^{17} **	3.06×10^{17} ***	1.41×10^{29} ***	2.51×10^{28} ***
benelux					1.3865	1.3688
scand					1.0125	1.0017
germany					1.2619	1.2755
fritch					0.4525 ***	0.4495 ***
y2					1.8939	1.8303
y3					1.4387	1.3622
y4					1.6277	1.5730
y5					2.7608	2.5962
y6					1.8440	1.7698
y7					2.3688	2.2246
df	376	376	373	373	363	363
LL	-1682.46	-1679.75	-1666.24	-1665.97	-1650.25	-1650.25
Chi^2	88.23	101.57	120.67	191.51	152.66	430.23
Pseudo-R^2	0.0256	0.0271	0.0349	0.0351	0.0442	0.0442

Figures indicate hazard ratios unless noted otherwise

***/**/* indicates significance at 1%/5%/10% levels

Results of Further Regression Analyses

While above controls account for the vast majority of general value influences, two aspects surprisingly have been neglected. These aspects extend prior value-related research by bringing it up to par with the more general streams of alliance literature. They are, however, neither particular to the European biotechnology context nor reflecting a fundamentally new paradigm of alliance research (as could be argued with regard to the value impact of contractual provisions and dynamic perspectives).

Table 171: Additional Hypotheses on Absorptive Capacity and Transaction Scope

(a) Absorptive Capacity
Going back to (Cohen and Levinthal 1990), focal firms' technological capacities have provided them not only direct benefits but also advantages in internalizing externally contacted knowledge. The improved absorptive capacity associated with high R&D investments thus tends to increase collaborative benefits [proposition 2.5]. At the same time, the technological know-how developed internally induces an expropriation risk in collaborative settings [proposition 3.1b]. Hypothesis A: Absorptive capacity has a positive, but marginally decreasing effect on collaborative value creation.

(b) Transaction Scope
The scope of collaborative activities may have a substantially positive impact on the corresponding wealth effects (see subsection 2.3.1.1). While this could be controlled for by itself, general alliance research has documented efficiency gains in broader alliances primarily when using equity-based governance (proposition 3.3). Consequently, the net effect of transaction scope may depend on the chosed governance schemes. Hypothesis B: Transaction scope increases announcement AR for joint ventures and/or equity-based collaboration.

Table 172: Regression Models on Absorptive Capacity and Transaction Scope

Variable	Main Effects of Focal Firm Resources			Interactions with Partner Resources		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
focalstafflog	-0,0194 ***	-0,0168 ***	-0,0186 ***	-0,0186 ***	-0,0191 ***	-0,0191 ***
ptype_ph	0,0346 **	0,0345 **	0,0347 **	0,0347 **	0,0295 *	0,0290 *
pregion_main	0,0452 **	0,0463 **	0,0461 **	0,0461 **	0,0435 **	0,0435 **
focalp5	0,0000			0,0000	0,0000	0,0000
focalp3		-0,0001				
focalpr			-0,0043	-0,0043		
pp					0,0000	0,0000
fpp						0,0000
intercept	0,0862 **	0,0784 **	0,0823 **	0,0823 **	0,0848 **	0,0849 **
DF	312	312	312	311	311	310
Adj. R^2	0,052	0,0536	0,0532	0,0501	0,0534	0,0504
F	5,3342	5,4772	5,436	4,3349	4,5654	3,7965
AIC	-473,42	-473,96	-473,81	-471,81	-472,90	-470,93

Variable	Transaction Scope			
	Model 1	Model 2	Model 3	Model 4
focalstafflog	-0,0199 ***	-0,0186 ***	-0,0182 ***	-0,0181 ***
ptype_ph	0,0351 **	0,0346 **	0,035 **	0,0347 **
pregion_main	0,0426 *	0,0403 *	0,0391 *	0,0392 *
scope2	0,0271	0,0282	0,0177	0,0151
f_rnd		0,0135	0,0065	0,0066
allequity			0,0581 ***	0,0561 **
equityscope				0,0109
intercept	0,0896 **	0,0763 *	0,0735 *	0,0734 *
DF	312	311	310	309
Adj. R^2	0,0565	0,0565	0,0779	0,0751
F	5,7319	4,7811	5,4497	4,6632
AIC	-474,93	-473,92	-480,24	-478,28

***/**/* indicates significance at 1%/5%/10% levels

Table 173: Discussion of Evidence on Absorptive Capacity and Transaction Scope

(a) Absorptive Capacity
Different measurs of focal firm technological skills were included in the regression models to control for absorptive capacity considerations: • Entering focal-firm resource variables into the regression models yields results consistent with the preceding correlation analysis (see Table 131): Broader resources bases are associated with lower wealth gains from collaboration. While all all three patent-related variables (focalp5 / focalp3 / focalpr) have negative coefficients even after correcting for firm size, only the effect of the patent-count over the three-year window starting in the year of alliance formation (focalp3) comes close to gaining significance. • More specifically, the interaction of focal and partner firms' patent bases (fpp) does not have a significant valuation effect. Absorptive capacity thus does not provide valuable learning advantages for a given level partner firms' technological resources. • Overall, the evidence contradicts Hypothesis A. It is, however, consistent with the findings on firm size, which may indicate that any kind of firm development (i.e., the establishment of commercial as well as technological resources) may reduce collaborative benefits. The fact that focal firms' technological competence does not have a significant value impact thus may be the average result of improved learning skills (absorptive capacity) and a reduced need for external learning. • Model 2, including only focalp3 as a firm-level control variable attains the highest R2, F and AIC values of all models. This suggests that the focal firms’ knowledge under development may be at least as important in reducing their collaborative gains as their formal patented knowledge.

(b) Transaction Scope

The present study distinguished between alliances extending beyond a main activity (scope2) in order to assess the effect of transaction scope. The coefficient on this variable is positive across different models (1.5-2.8%), but constsitently fails to gain statistical significance. Consequently, broader collaboration may have slight advantages, but they are immaterial; especially when employing more powerful controls, such as payments receivable and transaction value (results not reported here).

Further dissecting the impact of including the extensive functional collaboration dummy variable (scope2) as well as its interaction term with equity-based transction governance (equityscope) does not improves model fit (Model 4). The main effect of equity-based collaboration (allequity) remains highly signficant, whereas both *scope2* and *equityscope* are insignificant.

Appendix to Chapter 6: Discussion of Results and Conclusion

Table 174: Summary Contributions in Context of Prior Research

Theoretical School	Pro-position	Key Concepts	Level of Analysis	Prior Event Study Research	Controled for in Present Study	Hypothesized Effect in Present Study	Variable used in Present Study
Industrial Economics & Corporate Strategy	1.1	Market Power	Environment/ Transaction	■	■	□	Relatedness (Partner Type)
	1.2	Spillover Internalization	Transaction	■	■	□	Transaction Type (R&D)
	1.3	Market Entry/Barriers to Entry	Transaction	■	■	□	Transaction Type (R&D, Commercialization)
	1.4	First Mover Advantage	Environment	(■)	□	■	Development Stage (Exploration/ Exploitation)
	1.5	Positioning Alliance / Competitive Advantage	Environment	□	□	■	Business Model (e.g., Drug)
Resource-based View	2.1	Technological Capital	Firm/ Transaction	■	■	□	Partner Technology Base Transaction Type (R&D)
	2.2	Commercial Capital	Firm	■	■	□	Focal/Partner Firm Size, Focal Firm Age, Partner Resources
	2.3	Social Capital	Firm	■	■	□	Focal Firm Social Capital
	2.4	Alliance Experience	Firm	■	■	□	Focal Firm Alliance Experience
	2.5	Absorptive Capacity	Firm	□	□	(■)	Focal Firm Technological Capital (0)
Transaction Cost Economics	3.1	Asset Specificity	Firm/ Transaction	■	■	□	Contractual collaboration vs. equity-based governance
	3.2	Environmental Uncertainty	Environment	■	■	□	
	3.3	Transaction Scope	Transaction	(■)	□	(■)	Alliance Scope (0)
	3.4	Transaction Cost Perception	Firm	(■)	(■)	□	International Scope

Table 174 (Continued)

Theoretical School	Pro-posi-tion	Key Concepts	Level of Analysis	Prior Event Study Research	Controled for in Present Study	Hypothe-sized Effect in Present Study	Variable used in Present Study
Game/ Agency Theory	4.1	Information Asymmetries (Management-Owner)	Firm	(■)	(■)	□	Focal Firm per-formance/leverage/ growth opportunities
	4.2	Information Asymmetries (between Partners)	Firm/ Trans-action	■	■	□	Prior relations between partners
	4.3	Contractual Safeguards	Trans-action	□	□	■	Compensation Scheme Time Lim-itedness/ Optional-ity
	4.4	Inter-partner Trust	Trans-action	■	■	□	Prior relations between partners
	4.5	Patent Protection	Environ-ment	□	□	□	
Dynamic Theory	5.1	Environmental Change	Environ-ment	(■)	■	■	Environmental munificence Alliance Market Activity
	5.2	Environmental Uncertainty	Environ-ment	□	□	■	Market Uncertainty
	5.3	Firm Development	Firm	□	■	■	N/A (Split-Sample Analysis)
	5.4	Contribution to Firm Development	Firm/ Trans-action	□	□	■	Stage (Explore-/ Exploitation Focal Firm Resources (0)
	5.5	Alliance Evolution	Trans-action	(■)	□	■	N/A (Value effect of alliance forma-tion and termina-tion)

■ extensive evidence (■) limited evidence □ no evidence

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Let those who are in favour with their stars
Of public honour and proud titles boast,
Whilst I, whom fortune of such triumph bars,
Unlook'd for joy in that I honour most;
Great princes' favourites their fair leaves spread
But as the marigold at the sun's eye,
And in themselves their pride lies buried,
For at a frown they in their glory die.
The painful worrior famoused for fight,
After a thousand victories once foiled,
Is from the book of honour razed quite,
And all the rest forgot for which he toiled:
Then happy I, that love and am beloved
Where I may not remove, nor be removed.

William Shakespeare: *Sonnet 25*

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