Improving the performance of co-innovation alliances

Cooperating effectively with new business partners

Frans Stel

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PROEFSCHRIFT

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In open innovation,

the emphasis has shifted from what you know to who you know.

For Martian, Floor, Tobias, and Lucas

Preface and acknowledgements

In 1983, I attended courses at the Euro-Asia Centre at INSEAD regarding the impact of globalization on the management of joint ventures. I became fascinated by the changes in headquarter-subsidiary relations of multinationals. After graduation at the University of Groningen, I started a PhD-research concerning these themes. This research remained un-finished because of consultancy and management activities in industry.

In 2006, after two decades of conducting business development projects in both large and small industrial companies, I started my own management and consultancy company, CreateNewBusiness BV. I took the opportunity to finish my un-finished PhD-research. Being both a management consultant and a researcher, I was intrigued by the improvement of performance of business development networks, and, more precisely, in predicting and influencing performance of those networks more in detail.

Geert Sanders introduced me enthusiastically to Arjen van Witteloostuijn, professor of Applied Economics at the Universities of Antwerp, Utrecht and Tilburg. During many meetings, Arjen directed me through my scientific journey, while suggesting solutions for methodological challenges and offering thorough comments.

At an OECD-conference, I met Erik Brouwer, director at PriceWaterhouseCoopers and Professor of competition and innovation at the University of Tilburg. Erik became my econometric coach.

The cooperation with Arjen an Erik was the beginning of my intensive travel through alliance and innovation research. I express my sincere gratitude to both my promotores; although very active within their own research and consultancy practice, managed to find enough time to provide me with timely practical feedback.

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Furthermore, I thank Jonathan Wallen, for many years my neighboring "allochtone Drent", for preventing me from "verbal diarrhea" of jargon in the thesis during our discussions ending with a good glass of Chardonnay. I want to express my gratitude the International Business School Groningen and Esade Business school for their financial support and the Universities of Groningen and Antwerp for their operational support. I thank my paranymphs Jan Krediet, for many years my best man and ski-companion, and Jan de Vries, my sporty and academic friend, for their friendship.

Finally, my special thanks go to my dynamic wife and sparring partner Martian, who made this research possible by backing me during my intensive research journey, and our three wonderful examples of co-innovation: Floor, who conscientiously calculated over 16.000 scores, Tobias for his enthusiasm for life and Lucas for being my sporty chess adversary.

Zuidlaren / Torgon, march 2011

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1. INTRODUCTION

In this chapter, we introduce the thesis by clarifying key definitions, identifying the research objective, and presenting our research model. In addition, we motivate the structure of the dissertation.

Markets evolve over time, and companies, in turn, adapt their strategies and activities to changing market circumstances. Continuous renewal and innovation, therefore, are needed for corporate survival (Chesbrough, 2003; Haour, 2004). In order to preserve the core business *and* develop new business simultaneously, a capacity for reinventing new business proactively is essential (Collins, 2001; Kim and Mauborgne, 2005; Chesbrough, 2006; Markides, 2008). Making innovation a priority however, is not enough, as most innovations fail (Chesbrough, 2003); the most difficult aspect of innovation is its implementation (Skarzynski and Gibson, 2008).

Markets internationalize because customers and competitors increasingly act on an international scale (Ohmae, 1990). This has caused competition to intensify in many sectors; it has caused product life cycles to reduce drastically, roles of consumers to shift, and the integration of different technologies to accelerate (OECD, 2008). These trends have lead to increased technological, managerial and organizational complexity, and made innovation riskier, and more costly (OECD, 2008). Companies have been forced to cooperate with external partners in order to reduce innovation costs and development time, thus reducing the risks associated with innovation.

Collaboration in developing new products and introducing them to the market, known as open and collaborative innovation, has distinct advantages (Rigby and Zook, 2002), and is therefore not just another source of competitive advantage, but a competitive *necessity* (Kirschbaum, 2007). Open innovation is all about *"bridging internal and external resources"* throughout the innovation process in order to make innovation happen (Lindegaard, 2010:19). According to Huston and Sakkab (2006), open innovation will become the *dominant innovation model* of the twenty-first century.

1.1 DEFINITIONS

Our research focuses on co-innovation alliances. This type of alliance is considered to be *"an important instrument in future innovation because it is considered as the most efficient and effective means of innovation collaboration, and therefore increasingly popular in technology intensive industries"* (Lord et al., 2005: 134). Co-development alliances are increasingly important in open innovation models, because of their advantages due to the clear objectives and non-competing but complementary partnership character (Duysters and De Man, 2003; Chiamonte, 2006; Chesbrough and Schwartz, 2007). We define the open and collaborative innovation concept in box 1.1 and a co-innovation alliance in box 1.2.

Box 1.1: Definition of open innovation

"The use of purposive inflows and outflows of knowledge to accelerate internal innovations, and expand the markets for external use of innovation, respectively. Open innovation is a paradigm that assumes that firms can and should use external as well as internal ideas, and internal and external paths to market, as they look to advance their technology"

Source: Chesbrough et al. (2006: vii).

Box 1.2: Definition of a co-innovation alliance

"a business relationship, in which two or more independent firms or research institutes work cooperatively on a specific project, which is aimed at the development and commercialization of new products or services that is clearly defined in terms of activity, geographic location, product, process and time. Although partners remain to a certain extent independent, they also share rewards and risks"

Adapted from Slowinski and Sagal (2003:4).

1.2 RESEARCH OBJECTIVES AND MODEL

A great deal of research has been carried out on ex ante strategy processes, and much less on the ex post implementation of strategies (Boone et al., 1996). For success, careful strategy formulation is necessary, but this is not enough: surveys

of management consultants have shown that even if strategies are effectively formulated, approximately eighty percent of the strategies will be poorly executed. Consequently, these strategies will fail (Bible et al., 2006).

Cooperating with third parties in open innovation projects entails added complexities and risks. Even when potential synergies with partners are present, firms face substantial difficulties attaining them. In many cases, implementation of open innovation will evolve even more problematically than the usual in-house innovation. This challenge poses an important question, which is reflected in our research. Our aim is to contribute to improving implementation practices of these promising but risky co-innovation alliances by diagnosing the main critical success factors and processes. We summarize these in a comprehensive model, which we abbreviate with the letters COINN. This acronym stands for improving the performance of CO-INNovation.

We provide a balance between many different aspects of co-innovation alliances, including multiple dimensions of performance. We study the interplay between technological innovation and organizational innovation simultaneously because many of the performance drivers are interconnected and influence one another (Parkhe, 1993b; Makhija and Ganesh, 1997; Chiesa et al., 2009). In addition, implementation of multi-faceted strategies is more likely to lead to effectiveness than the implementation of monolithic strategies (Cameron, 1986); multiple determinants of competence transfer should be explained by several interdependent viewpoints (Chesbrough, 2003; Hansen and Løvas, 2004; Christensen et al., 2005).

We have therefore opted for a multi-dimensional and integrative research approach, in which structural aspects (organizational) and interpersonal aspects (relational) - such as trust, commitment, decision making or conflict resolution, and inter-organizational communication - will be evaluated in the co-innovation context (Cravens et al., 2000; Parkhe, 1993b; Bremser and Barsky, 2004; Davila et al., 2006; Kaplan and Norton, 2006; Chiesa et al., 2009). Interpersonal relationships are important because without strong relationship building, potential synergies from the alliance are likely to remain unutilized, causing the alliance to underperform. We include in our analysis the development of relational dynamics, competence development, and the development of organizational learning capacities of alliance partners (Parkhe 1993a; Gomes-Casseres, 1996; Kumar and Nti, 1998; Larsson et al., 1998; Madhok and Tallman, 1998; AWT, 2006a; and Chesbrough et al., 2006). Such an analysis becomes easily complicated easy when many variables interact with one another. Our scientific objective is stated in box 1.3.

Box 1.3: Research objective

The main objective is to develop, test and explore a theoretical and evidence-based model, which can serve as basis for constructing a management tool in order to diagnose and improve the performance of co-innovation alliances.

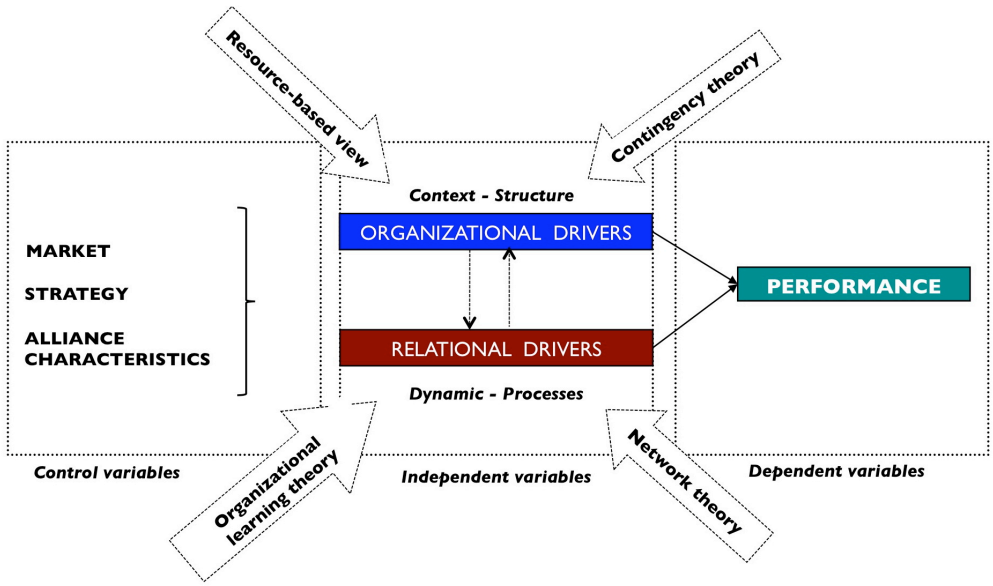
In order to develop and validate both model and tool, we pose the questions listed in box 1.4.

Box 1.4: Research questions

1. *Which factors and processes can be derived from the literature in order to diagnose and manage co-innovation alliances?*
2. *How do they differ in case of different objectives (commercial, technological, financial)?*
3. *Which changes in these factors and processes result in higher performance?*
4. *How do these factors and processes relate to one another?*

Our research is based on relevant literature, as well as on co-innovation practices. Our conceptual model is illustrated in Figure 1.1.

Figure 1.1: COINN research model



We study the relationships of organizational and relational drivers with co-innovation performance from four theoretical perspectives and evaluate the influences of market, strategy and alliance characteristics.

1.3 STRUCTURE

In Chapter 2, we indicate the relevance of our research by summarizing trends and their implications for innovation management. We position co-innovation alliances in the context of several types of alliances and various categories of innovation.

In Chapter 3, we discuss the contributions of relevant theories concerning performance of co-innovation alliances. We limit our research to contingency theory, network theory, organizational learning theory and the resource-based view. We have not chosen a single perspective from one theory, because key concepts from each of the chosen theories are complementary to one another (Mjoen and Tallman, 1997).

In Chapter 4, we develop our conceptual framework relating to three dependent variables – i.e., commercial, technological and financial performance. In order to provide an insight into the underlying factors driving performance, organizational and relationship drivers are introduced. General characteristics of the alliance partners, the market environment of the co-innovation project and the strategic drivers are added as control variables. Facilitating and blocking factors and processes are stipulated, with each section ending with one or more hypotheses. We use the results of studies about the performance of joint ventures, strategic alliances and inter-firm networks as means of developing our model.

In Chapter 5, we motivate the chosen research design. Our research objectives imply several methodological challenges and choices, due to the fact that information on the perceptions of managers have had to be gathered. Furthermore, we have to deal with a multi-industry scope, a multi-level character, and a mixed hierarchical (multi-level) and non-hierarchical (cross-classified) structure. For parametric tests, independency of observations is required. Our observations are to a certain extent correlated or nested, which has an influence on the appropriate statistical treatment. We also discuss the methodological choices and their implications in our research model and design, including our research activities. Furthermore, we will discuss our data collection process, as well as the companies, projects, partnerships and respondents that participated in our research. Before analyzing our data, we screen our dataset for missing values, outliers, sample size, and normality. Subsequently, we construct our scales, using principal component analysis techniques.

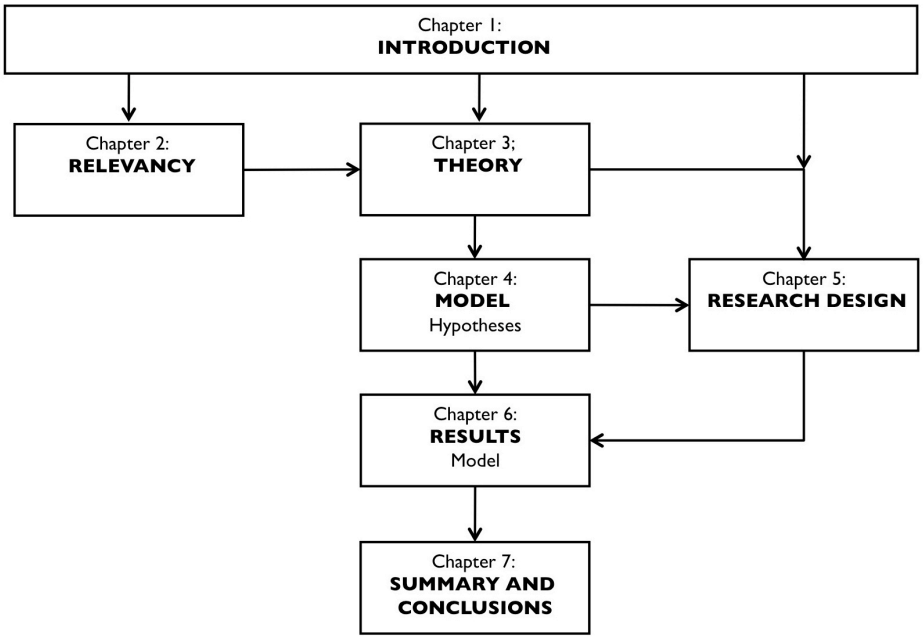
In Chapter 6, we present the empirical results from multivariate data analyses. In several regression models, we include different parts of our model.

We test the main linear and curvilinear effects of our model and conclude by discussing conditions that explain performance of co-innovation alliances.

In Chapter 7, we summarize the research, discuss the issue of improving the performance of co-innovation alliances, elaborate on the managerial implications and limitations of the research, and suggest avenues for further research.

The structure of the dissertation is illustrated in Figure 1.2.

Figure 1.2: Structure of the thesis



In boxes, we summarize or quote the highlights of the text. In figures, we illustrate theories and concepts. In tables, we juxtapose concepts or quantify calculations.

2. RELEVANCY AND POSITIONING

2.1 INTRODUCTION

In this chapter, we discuss the relevancy of our research and its position in the literature regarding alliances and innovation. Several trends generate increasing dynamism and complexity that affect the innovation strategies of companies. These trends imply that the implementation of innovation is an increasingly complex process, which results in a growing need for cooperation with external partner(s) in co-innovation alliances. New competences are necessary in order to implement the alliances successfully.

We discuss the different categories and definitions of innovation. We explore the advantages, disadvantages and applicability of the different types of innovation, and highlight in what respect the open innovation paradigm is new. One of the distinctions is between in-house (closed) innovation and innovation with external partners (distributed innovation). We will position the subject of our research, namely the co-innovation alliance. We conclude by summarizing the advantages of co-innovation alliances and potential obstacles during implementation.

2.2 TRENDS AND IMPLICATIONS

Customers and competitors act increasingly on a global scale, resulting in new and intensified competition. Furthermore, the development of new technology becomes increasingly more expensive and complex while technology life cycles shorten and products become more knowledge- intensive.

In many cases, it can be observed that companies that initially acted locally, gradually expand their scope and develop from regional players into national and even global protagonists. This results in new, intensified, and more dynamic competition (Bartlett and Ghoshal, 2000; Gassman, 2006). New Asian or Eastern European companies capture increasing market shares (Mahbubani, 2008). Competitors have to collaborate to establish industrial standards in order to build up enough market power to enforce it (Vanhaverbeke and Noorderhaven, 2001). For multinationals, it is increasingly difficult to maintain a competitive advantage on the basis of traditional economies of scale and scope *alone*. They have to "partner or perish". Competition between alliance blocks is replacing competition between individual firms (Prahalad, 1998; Vanhaverbeke, and Noorderhaven, 2001). In new markets, new standards have to be estab-

lished. In the 1990s, forming alliances was already seen as one of the most powerful trends in business. At that time, eighty-two percent of executives expected that alliances would be one of the prime drivers of future growth in their organizations (Kalmbach and Roussel, 1999). The number of alliances aimed at technological learning and knowledge creation has grown rapidly since the mid-eighties (Gilsing et al., 2007). By forming alliances, the speed of technological development can be increased. Research and development costs can be shared in order to meet the rising cost of technological innovation. Furthermore, within alliances, companies can manufacture goods for global markets, develop new products jointly, or seek access to foreign markets and technologies (Mowery et al., 1998).

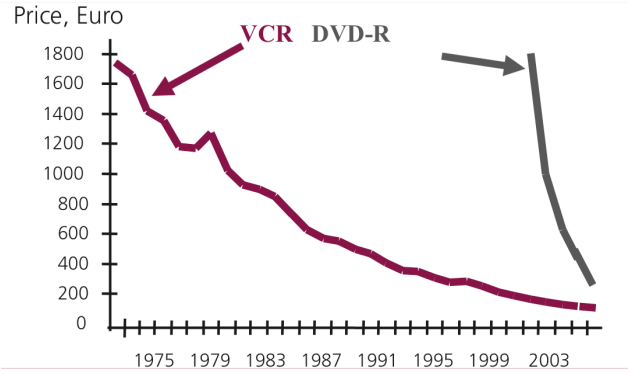
However, in addition to competition between alliance blocks, competition within alliances may also arise – e.g., in the case of cooperation with (potential) competitors. This balance between intra-alliance competition and collaboration is delicate and needs to be managed constantly (Brandenburger and Nalebuff, 1996). Firms must therefore position themselves strategically *among* as well as *within* alliances (Bamford et al., 2003). New forms of combined competition and collaboration involve new potential risks for co-innovation alliances - e.g., due to leakage of proprietary technology, improper strategic intentions of co-opetition partners, and complex decision-making within the alliance (Doz and Prahalad, 1984; Hamel, Doz and Prahalad, 1989; OECD, 2008).

A second trend is that the development of new technology becomes increasingly expensive and complex. Increasingly, a combination of different technologies that also have to be integrated is necessary (Chesbrough, 2006; Gassman, 2006; OECD, 2008, Schoenmakers and Duijsters, 2010). This phenomenon is known as 'technology fusion' (Gassman, 2006). Examples are mechatronics, optronics, bioinformatics or domotica. This implies more complexity of business processes and industrial borders that are shifting or even disappearing, resulting in more interdisciplinary cross-border research, and an increasing dependency on networks. In order to meet the increasing volatility in the markets, factories tend to become less dedicated to a single business line. Manufacturers become more flexible if they serve multiple, related business units in a larger market area: globalization of industries has been associated with growing interdependence across national markets (Doz and Prahalad, 1984; Prahalad, 1998). As a result of this, the interdependency between companies is increasing.

Gaining competitive advantage from cooperation is not new. The difference however, lies in the increased dynamism: positions are shifting more

rapidly and firms, and their alliances, face greater uncertainty. Existing technologies become obsolete more rapidly, requiring the necessity to develop new ones in time (Gilsing et al., 2007). Increased dynamism results in eroding existing competitive positions of incumbents, in shorter product life cycles, and consequently, a shorter payback period for new products (Andrew and Sirkin, 2006; Gassman, 2006). Life cycles of products and technologies become shorter due to fast *price erosion* of products, resulting in a growing *need for speed* in innovation (AWT, 2006). In order to compete globally, during a smaller *window of opportunity* (Moore, 2001), companies need to act faster and more effectively (Christensen and Raynor, 2003). As an example of fast price erosion, we show the development of the sales prices of video recorders and DVD-players in Figure 2.1. Because of technological trends, the need for interdisciplinary cross-border and cross-sector research is becoming more eminent, which transcend the innovative capabilities of single companies. Companies increasingly have to ally with partners with complementary expertise in order to obtain access to different technologies and knowledge quickly (Gassman, 2006; OECD, 2008), as illustrated in Box 2.1.

Figure 2.1: Price erosion of video recorders and DVD-players



Source: Hoekstra, Philips (2004) as cited in AWT (2006).

Box: 2.1: Too many opportunities

"No company is smart enough
to know what to do with every new opportunity it finds,
and no company has enough resources
to pursue all the opportunities it might put into practice"

Source: Wolpert (2002: 80).

A third trend implies that the knowledge intensity of products is increasing. Consequently, individual social relationships are essential, known as "soft technology", as in more personalized product design, computer software, consulting services, and entertainment aspects (Jin, 2005). The importance of soft technology is rising - contrary to hard technology, such as machinery and factories: for instance, in the processes of technology transfer and commercialization of technology. Furthermore, soft and hard technologies tend to be further integrated, and soft technology is transforming hard technology. Soft technology is less standardized and requires special talents (Jin, 2005). In certain cases, the role of the consumer shifts from customer to 'prosumer' by co-creating goods and services, rather than just consuming the end product (Tapscott and Williams, 2006).[1] In these cases, innovators rely heavily on their interaction with lead users, in order to develop new and customized products and services (Von Hippel, 2001, 2005, 2007). After this development with a few visionary early adopter consumers, new products must be introduced to more pragmatic mainstream market segments. This *'crossing-the-chasm'* is crucial for successful market introduction (Moore, 2001). For knowledge-intensive products however, *'crossing-the-chasm'* involves specialized knowledge and access to markets and distribution channels.

Jointly, these trends imply an increased organizational and managerial complexity (Doz and Prahalad, 1984). In general, in order to reduce this, cooperation with external parties becomes a necessity. More specifically, in new business development, companies increasingly need to rely on external partners, a phenomenon described by Chesbrough (2003a,b) as *open innovation*. For the implementation of open innovation strategies successfully, new competences are required, which will be discussed below.

The first implication, more organizational and managerial complexity, can be observed in the large number of participants and factors that influence decision-making. Multinational industrial customers and global competitors require globally integrated manufacturing. Global strategies are implemented and integrated through globally distributed but interdependent resources and activities. At the same time, industrial structures, distribution channels with specific customer needs, vary according to local markets, implying a need for local responsiveness. The paradox of acting globally and locally simultaneously demands an organization in which conflicting priorities between responsiveness

[1] This is also known as "swarm creativity", in which collaborative innovation networks are used to create competitive advantage (Gloor, 2006) or "Wikinomics", in analogy with Wikipedia, the collaboratively created encyclopedia (Tapscott and Williams, 2006).

at the local level and global strategies at the central level have to be addressed. In so-called multifocal (Prahalad and Doz, 1987) or transnational companies (Bartlett and Ghoshal, 1989), an appropriate balance between global integration and local responsiveness is managed. Part of this management process is sensing, mobilizing and optimizing: identifying new technologies globally (sensing), gaining access to them, putting them into practice by integrating internal and external capabilities (mobilizing), ultimately, optimizing the operations for efficiency and flexibility worldwide. This is known as a meta-national structure (Doz et al., 2001). Once such a structure has been established, it has to be maintained, which involves aspects such as building and retaining a capacity for flexible and quick response in order to handle potential technological discontinuities (Ghoshal and Gratton, 2002). Firms compete by using the flexibility, scale and scope of their international networks. In institutionalized network-based structures - i.e. headquarters, subsidiaries and partners - the relationships differ, both formally and informally (Devinney et al., 2000).

Alliances are considered an effective means of dealing with these complexities (Hagedoorn, 1993; Hagedoorn and Schakenraad, 1994; Osborn and Hagedoorn, 1997) because they have distinct advantages in the "knowledge economy" - e.g., in the form of customization, flexibility, and rapid response to complex tasks (Teece, 1992; Gomes-Casseres, 1994). There are however, certain complications with respect to command-and-control because of different ownership, dependence on alliance partners, or the integration of the alliance activities within the organization (Gomes-Casseres, 1994; Contractor and Lorange, 2002).

Increasing dynamism and uncertainty in industries demand shorter time-to-market periods. Alliances are often the chosen option for acquiring a new technology from outside instead of developing it in-house (Lambe and Spekman, 1997) or via mergers and acquisitions (Vanhaverbeke, Duysters and Noorderhaven, 2002).[2] Complexity and dynamism increases the companies' risks, while at the same time the risk tolerance of managers decreases, subsequently, management prioritizes short-term results and companies concentrate on their core businesses. The focus on projects that lead to short-term results implies a shift towards more incremental and less risky innovation in contrast to fundamental R&D and radical innovative projects, which require more time and carry a greater risk (Lindegaard, 2010). Companies tend to ally with knowledge sources or business partners in order to reduce development cost, time or risk. Instead of choosing a conventional two-company joint

[2] Another explanation for the increased number of alliances might be the fact that firm managers are following the cooperation activities of their partners (Haunschild, 1993).

venture, companies increasingly engage in more hybrid alliances (Parkhe, 1993; Doz and Hamel, 1998). To sum up, alliances have become a crucial component of building and sustaining a globally competitive advantage.

These trends imply a tendency towards innovative projects with external partners, because they benefit from the combination of external and internal knowledge sources during the development and introduction of new businesses. By collaborating with others - customers, suppliers and even competitors - a company is able to reduce time and development costs and increases the productivity of new business development. Furthermore, it enables a firm to refocus its own innovative resources. Through open innovation, external knowledge is used inside ("*outside–in*") and inside knowledge will be commercialized outside ("*inside-out*"). This combination can boost technological innovation, and is also a strategic or business model innovation (Chesbrough, 2003b, 2006). A business model describes the way value is created and captured.[3] In the case of open innovation, value will be created and captured with external entities.

In order to benefit from co-innovation alliances effectively, new competences are required (Hansen and Nohria, 2004; Isaksen and Tidd, 2006). This involves not only timely product development and introduction, but also knowledge transfer across markets and businesses, as well as continuous renewal and innovation with respect to organizational values, processes and practices. Innovative inter-unit collaboration cannot be implemented in a vertical command-and-control structure, but needs interaction at different levels simultaneously, because of the need to facilitate and benefit from bottom-up initiatives (Ghoshal and Gratton, 2002; Hamel and Välikangas, 2003; Govindarajan and Trimble, 2005; Trompenaars, 2007).

2.3 ALLIANCES

An alliance is used as an umbrella term referring to several forms of inter-firm cooperation arrangements between two or more separate companies, in which they share objectives, risk, return and control, as well as some operational integration and mutual dependence (Bamford and Ernst, 2002, 2005). This cooperation can be aimed at achieving short-term objectives or long-term competitive advantage (Contractor and Lorange, 2002). The alliance partners exchange and

[3] A business model describes the way value is created by identification of market segments and values chains, which includes the position of a firm within its value network (or ecosystem). Furthermore, in a business model, the captured value is specified by defining the cost structure and profit potential. In a business model, the competitive strategy is formulated as well (Chesbrough, 2003b, 2006).

share knowledge as well as resources with the intent of developing processes, products, or services (Gulati, 1998). The alliance should be advantageous for all partners involved (Das and Teng, 2000b; Duysters and Heimeriks, 2002b). The objectives of the partners in the alliance are interconnected, mutually compatible and difficult for each to accomplish individually (Spekman and Isabella, 2000; Todeva, 2000). While maintaining their own corporate identities and separate organizations, partners share reciprocal inputs (Vanhaverbeke et al., 2002). Alliances include structural and relational linkages (Todeva, 2000). The balances between those linkages evolve gradually. Alliances are therefore considered more complex to manage and relatively unstable compared with fully owned companies (Sydow and Windeler, 1998). Alliances include several cooperative arrangements ranging from weak inter-firm linkages (as in distribution agreement or logistical supply-chain relationship) to strong partnerships, as in equity joint ventures.[4] Alliances are embedded in a firm's strategic portfolio, and evolve within the firm's strategy and its competitive environment (Koza and Lewin, 1998).

Common elements in the aforementioned definitions of alliances are: (a) shared decision-making implying more than arm's length contracts through (b) a governance mechanism that is formed to pursue collaborative interests between (c) two or more independent firms that (d) share a variety of resources as in relational contracting, information exchange, joint learning and collective action with a (e) lack of full control and integration.

A metaphor of an alliance is shown in Box 2.2.

Box 2.2: Alliance as a marriage

"Alliances are much like marriages.
The partners have to understand each other's expectations,
be sensitive to each other's changes of mood and
not be too surprised if their partnership ends in divorce"

Source: Hindle (2003: 208).

The scope of an alliance may vary in duration or strategic autonomy. The duration may be open-ended and broad, as in strategic alliances, or specific, as in open innovation alliances (Cools and Roos, 2005; OECD, 2008). A licensing strategy offers an opportunity to source technology quickly, but with low

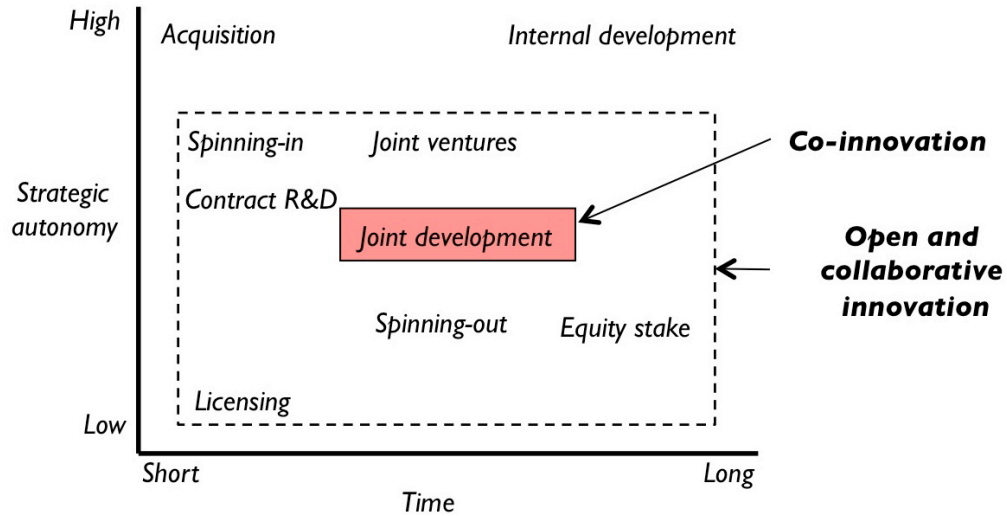
[4] The term "joint ventures" is used more narrowly for a separate business unit that is jointly owned by at least two organizations (Reuer, 2000).

autonomy, because of the remaining dependency on others. Acquiring technology offers high autonomy in the short-term, whereas developing it in-house provides a more time-consuming strategic autonomy. A co-innovation alliance can be considered to be a joint development alliance, which has an intermediary position, as visualized in Figure 2.2.

Co-innovation alliances are aimed at generating new business development in order to react to a rapidly changing environment. A co-innovation alliance has a certain, though limited synergy in a well-defined boundaries and narrowly defined objectives between non-competing partners that cooperate for a given period. Such an alliance can be considered as temporary[5] (Chesbrough and Schwartz, 2007). These narrowly defined tasks are there to reduce costs of R&D, learn from the capabilities of the alliance partners, jointly innovate in high-tech industries, shorten the development time, expand innovation output, or open up new markets (Mortara et al., 2009).

In our research, we adapt the definition of a co-innovation alliance fromSlowinski and Sagal (2003), as reproduced in box 2.3.

Figure 2.2: Positioning of joint development alliances



Source: adapted from the European Industrial Research Management Association EIRMA(2004) as cited in OECD (2008).

Co-innovation focuses on joint development cooperation, while open and collaborative innovation involves other types of cooperation with external parties as well.

[5] Named by Duysters and De Man (2003) 'transitory alliance' and by Dussauge et al. (2000) 'link alliance'.

Box 2.3: Definition of co-innovation alliance[6]

A business relationship in which two or more independent firms or research institutes work cooperatively on a specific project that

- *is clearly defined in terms of activity, geographic location, product, process and time,*
- *is aimed at the development and commercialization of new products or services,*
- *retains an agreed level of flexibility, as each firm makes specific commitments to one another within the scope of the alliance, each can work independently of the other on projects outside the alliance,*
- *shares rewards and risks of the project, which may go beyond measurable financial return to include new intellectual property, skills sets, opportunity cost, and market position,*
- *commits resources to the relationship in order to accomplish the objectives of the alliance.*

Adapted from: Slowinski and Sagal (2003:4).

2.4 INNOVATION

Innovation is not synonymous with research and development (R&D). Innovation can be defined as: *"the transformation of an idea into the launching of a new or improved product, a new or improved industrial or commercial process, or a new method in which to serve society"* (OECD, 1994: 84), and R&D as *"creative work undertaken on a systematic basis in order to increase the stock of knowledge, including the knowledge of man, culture, society, and the use of this knowledge to devise new applications"* (OECD, 1994: 84). R&D converts money into knowledge, whereas innovation transfers knowledge into money, or creativity that has been put into practice. R&D is an essential part of innovation, whereas innovation relates to more aspects. Innovation involves the total process of the development of a novel element in a business proposition *including* commercialization (Andrew and Sirkin, 2006).

[6] Known as a "non-equity alliance", which do not involve a separate entity or equity sharing by the participants. Instead, the following items have to be agreed upon: scope of the objectives, key responsibilities of the partners, governance, operational management, contributions, cost allocation, sharing of profits or income, disclosure of proprietary information or technology, licences for existing IPR, inter-party transactions, liabilities and indemnity of the partners, exclusivity, term, and termination (Freshfield Bruckhaus Deringer, 2005).

Normally, there are more ideas than can possibly be exploited (Hindle, 2003, Gassman, 2006). Therefore, the main issue is how to manage the innovation process so that it creates economic value. In many cases, innovative projects will not deliver the expected results, although innovation ultimately leads to new business, as quoted by a manager of the innovative company 3M, reproduced in box 2.4.

Box 2.4: Innovation and serendipity

"You have to kiss a lot of frogs to find the prince.
But remember, one prince can pay for a lot of frogs"

Source: Hindle (2003: 123).

Innovation can be characterized by the degree of novelty, aggregation level, type of innovation, and degree of openness.

First, when we classify innovation by the degree of novelty, we distinguish incremental innovation *("doing what we do better")* from radical innovation *("new to the world")*. A large proportion of the innovation activities in companies have an incremental character. In this case, new features are added to existing products, or the innovation is aimed at increased efficiency. Inherently, incremental innovation involves less risk than more radical innovation because of the lower degree of novelty. Depending fully on incremental innovation involves certain risks, because the development of new business is limited. In order to develop enough new business, companies have a growing dependency on discontinuous innovation, which includes specific innovative competences (Hamel, 1998). In mature industries, companies usually rely more on incremental innovation; in new industries, companies rely more on fundamental, breakthrough or game-changing innovation (Christensen et al., 2004; Tidd et al., 2005; Meijer, 2006; Lafley and Sharan, 2008). Radical inventions are to a higher degree based on emerging technologies and on combining diverse knowledge domains of emerging and existing knowledge. Within open innovation alliances, technologies can be combined effectively (Schoenmakers and Duysters, 2010).

As second classification of innovation, we distinguish innovation at several aggregation levels: within a team, a firm, between firms, at industrial level or in an entire economic system. Another distinction relates to the component level juxtaposed to the aggregated system level. Innovation at the component level concerns improvements to components, the addition of new components to existing systems or advanced materials in order to improve component per-

formance. Innovation at the aggregated system level is known as systemic innovation (Nooteboom, 2000; Tidd, et al., 2005). In our study, we concentrate on systemic innovation at the organizational and inter-organizational level.

Third, if we classify innovation by type, we can distinguish product, process, position and paradigm innovation (Tidd et al., 2005). These types do not exclude one another. Product innovation is aimed at changes in products or services, which an organization offers – e.g., by inventing new technologies. Process innovation will result in changes in the ways products or services are created and delivered, usually considered to be incremental innovation. Position or paradigm innovation[7] affects changes in the context in which the products or services are introduced, for example via changes in the underlying business models the organization uses, such as changes in the redesign of chains of production, supply, and distribution (Nooteboom, 2000; Tidd et al., 2005; Von Stamm, 2008). Kim and Mauborgne (2005) describe some examples of business model[8] innovation. Rather than competing in 'bloody red oceans', i.e. markets with fierce competition, companies innovate their business models through eliminating or reducing unwanted elements. These companies concentrate on new or less contested 'blue ocean' market propositions.

Fourth, another distinction relates to the extent of openness. We position our research in this framework of open innovation approaches. Open innovation has been defined in Chapter 1, box 1.1. The main element involves a deliberate balance between the usage of external and internal competences, whilst considering external relationships as deliberately chosen rather than a useful side-effect (Chesbrough, 2003, 2006). Open innovation is both a set of practices using external sources, such as in the usage of innovation intermediaries, commercializing un-used in-house developed technology, spinning-out of innovation projects, sale of innovation results to third parties or innovating business models using innovative ecosystems.[9] At the same time, it is a cognitive innovation model – i.e., an open mentality *("proudly found elsewhere")*. In open innovation, it is assumed that relevant knowledge is abundantly available outside firms that can be used outside the company *("outside-in")* in order to generate new ideas, develop and bring them quickly to the market. In addition, companies exploit their own intellectual property *("inside-out")*. Intellectual property is considered to be a temporary asset as well as a source of revenue,

[7] Tidd et al. (2005) separate position innovation (repositioning of a perception of a product) from paradigm (business model) innovation. In practice however, these types appear simultaneously.
[8] See the definition of a business model in Section 2.1.
[9] An innovation ecosystem is a network of a corporate innovator with knowledge institutions, suppliers, service providers, development agencies, etc.

which should be commercialized in time (Chesbrough et al., 2006). Furthermore, in the open innovation approach, the risk of unjustified (dis)approval of continuation of innovation projects – false negatives and false positives – is assumed to be too large due to uncertain and changing conditions. Therefore, rather than (dis)continuation of in-house innovation projects, more options should be considered, such as licensing-out or spinning-out of activities. In the closed innovation approach, innovation involves mostly the process between invention, research, development and market introduction (discover-develop-ship). In the open innovation approach, the innovation process is more dynamic and less linear (OECD, 2008). In this aspect, open innovation differs from the traditional closed innovational approach,[10] as illustrated in Table 2.1.

Table 2.1: Principles of closed and open innovation

Closed innovation	***Open innovation***
The smart people in our field work for us.	*Not all the smart people work for us so we must tap into the knowledge and expertise of bright individuals outside our company.*
To profit from R&D, we must discover, develop and ship it ourselves.	*External R&D can create significant value; internal R&D is needed to claim some portion of that value.*
If we discover it ourselves, we will get it to the market first.	*We do not need to originate the research in order to profit from it.*
If we are the first to commercialize an innovation, we will win.	*Building a better business model is better than getting to market first.*
If we create the most and the best ideas in the industry, we will win.	*If we make the best use of internal and external ideas, we will win.*
We should control our Intellectual Property (IP), so that our competitors do not profit from our ideas.	*We should profit from other's use of our Intellectual Property (IP), and we should buy others' IP whenever it advances our own business model.*
Scope: "The lab is our world".	*Scope: "The world is our lab."*
Mentality: "Not Invented Here."[11]	*Mentality: "Proudly found elsewhere."*
Know-how is most important.	*Know-who is important.*

Source: Chesbrough (2003a) and Philips.

Open innovation offers an opportunity to achieve a new source of competitive advantage, as illustrated by a quote from an executive of Procter & Gamble in Box 2.5.

[10] These differences explain why the open innovation concept is not "old wine in new bottles", as suggested by Trott and Hartmann (2009).
[11] Described as a tendency of managers to believe they have all the necessary knowledge in-house and therefore are rejecting ideas from outside (Katz and Allen, 1982).

Box 2.5: A new source of competitive advantage

"There are many kinds of competitive advantage.
The original view was: I have got it, and you don't …
Then there is the view, that I have got it, you have got it, but I have it cheaper …
Then there is I have got it, you have got it, but I got it first …

Then there is I have got it, you have got it from me,
so I make money when I sell it, and I make money when you sell it."

Source: Chesbrough (2006: 201).

Recent research on innovation with external partners can be grouped into three major streams (West and Bogers, 2009): open innovation, user innovation, and cumulative innovation. All three approaches concentrate on innovational interaction with external parties but at the same time differ from one another. Most research has been carried out on user innovation; research on the open innovation paradigm is growing more rapidly, while cumulative innovation has been studied less (West and Bogers, 2009).

The first approach, open innovation, focuses on organizational innovation by selecting the best combination of external and internal resources. Resources of firms with external partners are exchanged in outside-in and inside-out value networks in which firms commercialize other's innovations. These networks are worldwide *("the world is my lab")*. Intellectual property and spillovers are being commercialized – e.g., via licensing or corporate venturing. An example of the use of open innovation is the 'Connect and Development' program of Procter and Gamble (P&G), in which P&G systematically scouts the world for proven technologies and products that P&G can improve, scale up, and market, either on its own or in partnership with other companies. P&G realized substantially better, faster and cheaper product development: the innovation success rate more than doubled, while the cost of innovation has fallen. Many more new products were launched, R&D productivity at P&G has increased by nearly sixty percent and R&D costs as percentage of sales has dropped thirty percent. The quote in box 2.6 illustrates this. Examples of work in the open innovation stream are Gilsing et al. (2008), Nambisan and Swahney (2008), Chesbrough (2003b, 2006), and Laursen and Salter (2006).

Box 2.6: Open Innovation example: 'Connect and Develop'

"The Connect and Develop strategy will become
the dominant innovation model in the twenty-first century.
For most companies, the alternative invent-it-ourselves model
is a sure path to diminishing returns"

Source: Huston and Sakkab (2006:66).

The second category of research is on user innovation. The focus here is on a new business model,[12] in which users are assumed to have the knowledge and motivation to contribute - without financial compensation - to innovations that solve needs which so far have not been met by existing producers, while producers commercialize the products. The level of analysis is mostly that of individuals, who freely reveal their innovations to other users and producers. Examples of user innovation are open source software, such as Linux, or the internet encyclopedia Wikipedia. References from the user innovation literature are von Hippel (2001, 2005, 2007), Gloor (2006) and Tapscott and Williams (2006).

The third stream of research studies is cumulative innovation. Here, competing firms use the technological knowledge-spillovers of others for their own technological innovation. For instance when such knowledge is not easy to protect, intellectual property might not be protected,. The level of analysis is usually the refinement of technology by explicit cooperation and knowledge sharing, or building upon unprotected knowledge spillovers of competitors. An example is the publically available pool of specialized information in the biopharmaceutical drug industry. References are Allen (1983), Nuvolari (2004), Scotchmer (2004), and Murray and O'Mahony (2007).

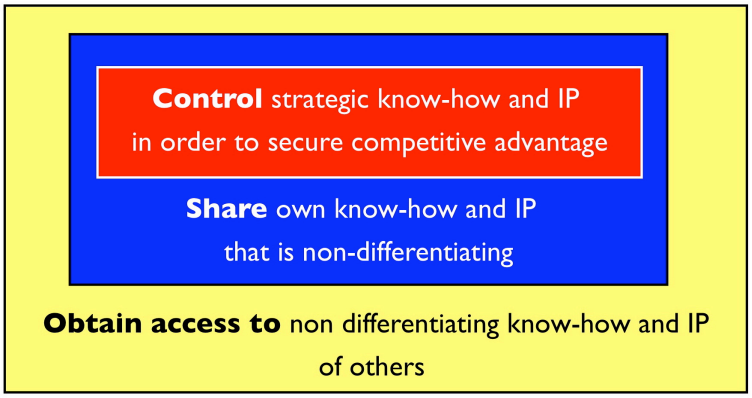
Our research concerning co-innovation alliances shows that companies choose to develop and market their products jointly with external partners. The openness however, is relative, because openness is only conducted towards (a network of) selected partners, in which firms decide to cooperate exclusively, and only to a limited extent. The exclusivity is usually restricted to a certain period, activities or geographic location. After this, no further obligation exist, although - depending on the results of the previous cooperation - new contracts may be agreed upon.

According to Chesbrough (2003b), openness to third parties can be described as a continuum from a higher to a lower degree. The degree of open-

[12] Defined in Section 2.1.

ness may vary according to the subject matter. We add to this the dynamic aspect: openness varies with time – e.g., according to the development phase. In addition, we argue that openness is differentiated per subject (openness on a need-to-know basis), varies per partnership, and has a formal and informal aspect (personal and organizational openness). The protection of know-how and intellectual property (IP)[13] is dependent on the strategic value of IP; firms tend not to share strategic know-how - i.e., IP that is considered to be essential for competitive advantage of the core business. They share and develop non-differentiating know-how and IP with only selected partners. Finally, they give others access to generic non-differentiating IP and expect knowledge-sources, such as research institutions or experts, to build upon the IP, which might be beneficial to everybody. This is illustrated in Figure 2.3.

Figure 2.3: IP protection dependent on type of IP



Source: Van der Walle, Philips (2007).

Disclosure of know-how and IP to external parties depends on the strategic value of it to a company.

We discuss the application of the different types of innovation by way of a matrix, in which the originality of the innovation in terms of technology and market are described (table 2.3). Process innovation is aimed at increasing the efficiency while incremental innovation adds new features to existing products. This type of innovation is used in the case of fine-tuning of existing technologies for existing markets, and usually carried out in-house (closed innovation).

[13] Know-how can be defined as accumulated skills. Examples of IP are patents and trademarks. We discuss the differences of know-how and IP further in Section 3.5 on organizational learning theory.

Technological innovation is directed at developing new technologies for existing markets – e.g., in order to reduce cost price when competition is tough. Organizational or business model innovation is used in cases where existing technologies are applied to new markets. By innovating the business *ecosystem*, new markets are developed. Radical innovation will be applied in the case of innovations that are aimed at new markets *and* technologies. With these innovations, higher rewards may be achieved, although at a higher level of uncertainty and risk. This classification is summarized in Table 2.2.

Table 2.2: Innovation approaches by market and technology

MARKET	TECHNOLOGY: Adjacent	TECHNOLOGY: New
New	Business model: => open innovation	Discontinuous, disruptive, radical, game-changing, breakthrough innovation: => open innovation
Adjacent	Incremental, process: => closed innovation	Technological innovation, => sometimes open innovation

Adapted from: Davila et al. (2006).

An example of a co-innovation project is the Senseo-alliance, the cooperation between Philips and Sara Lee/Douwe Egberts in developing and marketing a new coffee-making system. Co-innovation research differs to a certain extent from these aforementioned three approaches. In contrast to these streams, within co-innovation, external relationships with co-developers are observed, instead of a focus on worldwide networks, users or competitors. In co-innovation, the locus of innovation is at the aggregate level of the firm and beyond (instead of outside a firm, at user level, or society), the cooperation is aimed at achieving strategic, technological or financial targets (rather than just financial, utilitarian or technological objectives), spillover knowledge is not free as intellectual property is protected - sometimes jointly - by ad hoc agreements. In addition, the innovation mode is selectively cooperative, in which innovators share knowledge or resources selectively only during predefined stages (instead of *"inside-out"* and *"outside-in" or "user feedback"*). Furthermore, co-innovation is usually applied to more radical or business model innovations. The differences between the closed innovation and the streams of collaborative innovations – open, user, cumulative and co-innovation – are summarized in Table 2.3.

Table 2.3: Different innovation approaches

	CLOSED Innovation	***OPEN Innovation***	***USER Innovation***	***CUMULATIVE Innovation***	***CO-Innovation***
Level of analysis	firm	firm	user	society	firm
Locus of innovation	within a firm	outside a firm	within users	within many firms	between two or more partners
Spillovers	blocked	paid	free	free	conditional
External interactions	--	market exchange with others in a value network	cooperation between users and producers	competition between competing firms	exchange of competences between co-developers
Network	no external network	based on "the world is my lab"	fluid	overlapping network	based on complimentary competences
Performance objectives	profit	profit	increased utility	technological	commercial, technological, financial
IP protection	complete protection	IP is used for inside out and outside in flows	weak IP protection	some IP protection	selective transfer of IP, agreement per project (phase)
Innovation mode	internal control aimed at "*develop-> discover->ship"*	best-of-breed: "*outside in - inside out"* philosophy	users give feedback, producers commercia-lize	with rivalry	partners are selectively cooperative
Innovation focus[14]	incremental, technological innovation	radical, organizational, business model innovation	business model, radical innovation	incremental innovation	radical, technological, orga-nizational, business model innovation

Adapted and completed from West and Bogers (2009).

Several advantages of innovation cooperation with external partners can be distinguished, as is listed in Box 2.7.

[14] This does not imply that other types of innovation are excluded.

Box 2.7: Advantages of external innovation cooperation

1. *Access to complementary competences*
2. *Risk sharing*
3. *Increased flexibility*
4. *Additional return on R&D investment*
5. *Increased R&D productivity*
6. *Improvement of innovative culture*

External experts, such as lead users, component suppliers or universities, may have the unique knowledge of the key technologies necessary to develop new products. Cooperating with them provides a broader spectrum of ideas. In addition, technologies and resources can be accessed while avoiding the huge costs of in-house development.

A second advantage is that the risks of innovation can be shared between the partners, and reduced because of the beneficial effect of additional competences.[15]

A third benefit is external cooperation, through which flexibility and responsiveness towards markets can be increased, involving not only an increase in the speed of exploration, but also of exploitation.

Furthermore, additional return on internal R&D investments may be gained from licensing or the spinning out of otherwise un-used intellectual property.[16]

In addition, by allying, corporations can focus on their highest-potential opportunities by combining their core innovation competences with external ones, thus increasing the productivity of R&D, as well as the speed and quality of new product introduction. In the case of closed innovation, a company relies fully on its own R&D without openness to the external environment.

Lastly, through the relationships with external expertise, a company can improve its innovative culture (OECD, 2008). The ability to exploit external knowledge is a critical component of innovative performance (Cohen and Levinthal, 1990). Firms that are more open to external knowledge sources can deepen their technological competencies faster, and consequently become

[15] Andrew and King (2003) state that breakthrough ideas have failure rates of between sixty and eighty-five percent and that improving the success rate of innovation projects has a larger impact than only reducing costs.

[16] Companies sometimes follow a "use it or lose it" strategy, implying the external use of intellectual property after this remains unused internally. This creates a sense of internal urgency concerning those internally available technologies (OECD, 2008).

more innovative (Haour, 2004; Laursen and Salter, 2006). however, after reaching a certain optimum level, additional search for new competences becomes unproductive (Laursen and Salter, 2006). The openness to relevant external sources therefore needs to be managed carefully, resulting in a changing degree of openness to partners.

Benefiting from the advantages and simultaneously avoiding the disadvantages, demand effective management. An adequate way of implementating of innovative projects is essential for achieving results. Part of this involves finding the right mix of innovation activities vis-à-vis a firm's current strategy, its markets and technologies. In addition, a balance between sufficient new business development and existing activities is indispensible. Ultimately, it is important to realize that the management of co-innovation alliances follows a cycle of processes, as will be explained in the following section and illustrated in Figure 2.4.

It is essential to establish the right mix of innovation types, which is missing in many companies (Moore, 2005). The challenge facing management is being able to choose and pursue an adequate type of innovative activity, which fits in with specific strategies, markets and technologies. For example, in the early phase of a products life cycle, other types of innovation are required than those used in mature or declining markets (Moore, 2005). Usually, core competencies (in technology and markets) will be developed internally where possible, in order to avoid the risks of cooperation with external parties – e.g., lack of control, dependency on others, and the potential lack of protection of intellectual property. In other cases however, open innovation may be more appropriate because it enables faster, and less costly development, while at the same time incurring fewer risks. When a technology is considered to be non-core, but has to be used in core markets, a company may choose between developing it internally, outsource or license it. Core technology for non-core markets can either be acquired from outside or developed jointly. In this case, a company may develop its technological capabilities. For obtaining access to unfamiliar technology for a core market (or to core technology in an unfamiliar market), joint ventures or contract R&D alliances are usually the appropriate vehicles. As long as the technology and/or the market is important without being vital, companies will seek to perpetuate involvement with the use of internal corporate venturing units, corporate incubator organizations or external venture capital (Vanhaverbeke and Peeters, 2005). Activities that consist of unfamiliar technologies for unfamiliar markets will generally be divested. Co-innovation alliances tend to be aimed at developing new tech-

nology or market rather than a means of incremental innovation. The relationship between a companies' strategic portfolio in terms of markets or technologies and the appropriate modes of innovation is illustrated in Table 2.4

Table 2.4: Innovation modes: technology and markets

MARKETS	Core	Non-Core	Unfamiliar
Unfamiliar	Joint venture Contract R&D	Venture capital Internal venture fund	Spin-off Sell
Non core	***Joint development*** Acquisition	Licensing Equity stake	Venture capital Internal venture fund
Core	Acquisition Internal development	Internal development Licensing Acquisition	Joint venture Contract R&D

TECHNOLOGY

Source: EIRMA (2004), adapted from Roberts and Berry (1985), as cited in OECD(2008).

A balance between innovative and existing business activities is important. Innovation should be integrated into the business so that sufficient attention will be given to investment in new businesses in addition to the current existing core business (Campbell and Park, 2005; Davila et al., 2006; Lafley and Sharan, 2008). It is difficult to find an appropriate balance between the exploitation of existing business and the exploration of new and innovative business, because the different activities require different cultures, leadership styles, structures and competences (O'Reilly and Tushman, 2004).[17] Such a balance is important because of the need to develop enough new business in addition to the current ones. In order to remain competitive, companies have to absorb new knowledge and integrate it within their current business (Prahalad, 1998; Campbell and Park, 2005; Lafley and Charan, 2008). For this reason,

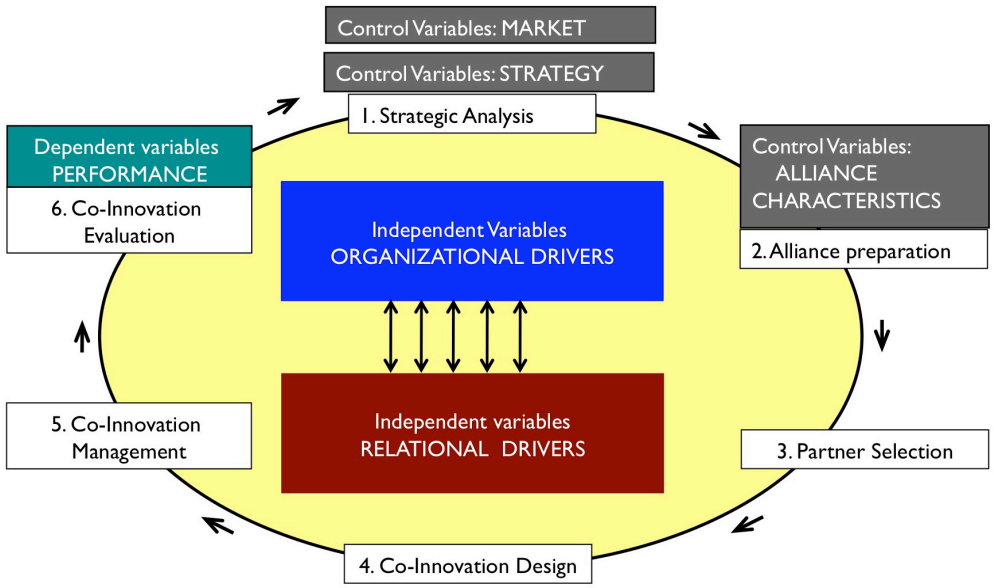
[17] O'Reilly and Tushman (2004) call companies which can combine these activities "ambidextrous".

companies need to shift from a product-centered view to a systemic view of innovation in which the business model[18] itself is innovated (Hamel, 1998; Chesbrough, 2006; Vanhaverbeke, 2008). This implies a shift of focus on technological innovation to an innovational approach, which involves business model innovation in order to change the rules of the game (Hamel, 1998; Christensen and Raynor, 2003; Lafley and Charan, 2008).

Finally, the managerial tasks of co-innovation alliances follow a cycle of processes.[19] The management of an alliance is to a certain extent similar to conducting a merger or an acquisition. The implementation process involves strategic analysis, alliance preparation, partner selection, design, management and the evaluation of the co-innovation alliance.[20]

In our research, we focus on the organizational and relational drivers of co-innovation performance. The analysis can be used for preparing the alliance, selecting partners, designing, managing, and evaluating the partnership, as described by Bell (2003). In our analysis, we assess strategic and market influences, as illustrated in Figure 2.4.

Figure 2.4: COINN Model related to the co-innovation cycle



[18] See the definition of a business model in Section 2.1.
[19] See Lorange and Roos (1993), Porter Lynch (1993), Callahan and MacKenzie (1999), Spekman et al (2000), Bell (2003) and Segil, (2004).
[20] Careful selection and evaluation of partners improve the effectivity of an alliance (Bucklin and Sengupta, 1993). Pansiri (2005: 1102) summarizes evaluation criteria for alliance partners with 4C's: Compatibility, Capability, Commitment and Control.

Apart from these activities, an entrepreneurial spirit is indispensible, as illustrated in Box 2.8.

Box 2.8: Innovation according to Richard Branson

"An innovative business is one which lives and breathes "outside the box". It is not just good ideas, it is a combination of good ideas, motivated staff and an instinctive understanding of what your customer wants"

Source: Richard Branson, 1998, as cited in Tidd et al. (2005: 66).

2.5 ORIGINALITY AND PRACTICAL VALUE

For many organizations, temporary alliances are an increasingly important part of their strategy (Duysters and De Man, 2003; Chesbrough and Schwartz, 2007). Consequently, assessing the performance of such alliances becomes a priority. Performance evaluation is a critical success factor for alliances. The reality however, is that formal performance evaluation processes are not widely used, due to the unique nature of the alliances (Cravens et al., 2000). The same applies to innovation; the Boston Consulting Group (2006b) concludes that innovation is seldom measured properly and companies that measure their innovative activities are not usually confident or satisfied with their systems of measurement. According to a McKinsey survey in 2004, about eighty percent of alliances are underperforming. The management of alliances is more complicated than the management of corporations, and appropriate performance diagnosis and a system for measuring the performance of alliances are lacking (Bamford and Ernst, 2005). No reliable and validated measuring system is as yet available to co-innovation ventures. In our research, we develop a basis for such a measurement system as a means of developing a formal assessment approach that links performance evaluation to the objectives of the alliance. The result is a generic template that can be adapted to the specific evaluation requirements. It is important to start the evaluation process early, before problems lead to mistrust, counterproductive behavior or underperformance (Gulati, 1998; Bamford and Ernst, 2005). With the use of our model, managers can proactively re-direct their alliances, if necessary.

Our COINN-instrument is innovative because it is multifaceted, integrative and evidence-based (Chesbrough et al., 2006; Sorge and van Witteloostuijn, 2007). Furthermore, dealing with the drivers and their influence on performance, reflects a dynamic view of alliances (Gilsing et al., 2007). The effects of organizational and relational aspects on performance is integrated in our model. We base our model on the evidence from several industries, such as high-tech, fast-moving consumer goods and service industries, as well as those of companies of varying sizes ranging from large multinationals down to small and medium-sized enterprises. We measure the effects of our variables on performance during several phases of the business development, and take a balanced view of performance in which tangible and intangible aspects are considered. All this will be explained in much greater detail in the following chapters.

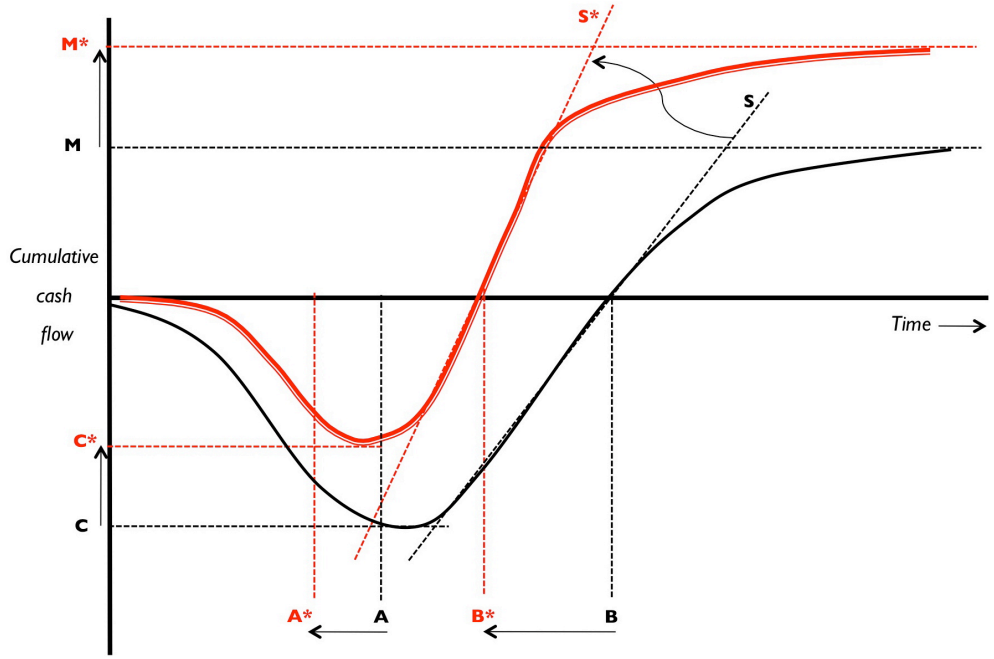
2.6 SUMMARY AND CONCLUSIONS

In our research, we focus on the implementation of co-innovation alliances. These partnerships are aimed at the specific well-defined tasks of co-development of new products or services and co-market introduction of new business, but do not usually involve joint equity or a separate legal entity. We do not concentrate on more loosely structured more open networks, which often involve a larger number of collaborators; open networks often have different, less focused, objectives, and face different management issues.

Innovation starts with idea generation, followed by phases of technical and commercial development. During technological development and in the early phase of commercial development, cash flow will be negative, and after market introduction, positive. We measure the advantages of co-innovation by plotting the cumulative cash flow illustrated in Figure 2.5. By cooperating with external partners, commercial, technological and financial advantages can be gained. By sharing technological competences, through more effective learning, the time-to-market can be shortened: products can meet their break-even point more rapidly with the advantage of (B-B*) shown in Figure 2.5, and technological risks shared between the partners. At the same time, by sharing costs, the cumulated project costs can be limited with an advantage of (C-C*). Another way of increasing innovation performance is by lowering the costs of commercialization, which can be achieved be using the competences and resources of outside partners (Andrew and Sirkin, 2006). Furthermore, through combining sales, market forces or distribution channels, strategic synergy can

be obtained, resulting in scale advantages (S-S*), less time-to-volume, shared market risk, better strategic position, or a larger market. Furthermore, additional revenues may be gained from licenses, spin-offs or divestures to external parties (M-M*). A potential disadvantage of cooperation however, might be the need to share markets or margins with partners. A successful co-innovation implies that ultimately the net effect of the cooperation will be a larger (attainable) market.

Figure 2.5: Advantages of co-innovation



Adapted from Andrew and Sirkin (2006).

Commercial, technological and financial advantages of co-innovation:

*In the **technological development** phase, major advantages are*
- *a reduction of the time-to-market (from A to A*),*
- *a faster breakeven situation (from B to B*),*
- *less development costs (from C to C*).*

*In the **commercial development** phase, major advantages are*
- *faster up-scaling,*
- *less time-to-volume (from S to S*), and*
- *a larger market attainable through sharing of distribution channels, licensing, spin-offs or divestures (from M to M*).*

In conclusion, co-innovation has potential commercial, financial and technological advantages. Examples of commercial advantage are the sharing of distribution channels resulting in reduced market risk and a larger attainable market. Technological advantages can be derived from access to complementary competences, which results in shared or reduced technical risk and a more innovative culture. Examples of financial advantages are a higher level of innovation productivity and output, additional return on R&D, rapid product development, and faster market introduction and penetration.

Open and collaborative innovation carries with it potential disadvantages, such as extra governance costs, complexity of management due to the absence of hierarchical leadership, an over-dependence on partners, opportunistic behavior of partners, the dilution of margins, a lack of disclosure of vital information, and the increased risk of leakage of proprietary information to potential competitors.

In addition, the implementation of co-innovation alliances requires new managerial tasks - e.g., the management of potentially conflicting priorities between existing businesses as well as alliance partners, or the management of new sources of information, such as specialized innovation intermediaries, external ventures or incubator organizations (Vanhaverbeke, 2008). Furthermore, in order to implement co-innovation successfully, new roles have to be conducted, such as the "cross-pollinator" role (Kelley, 2005).

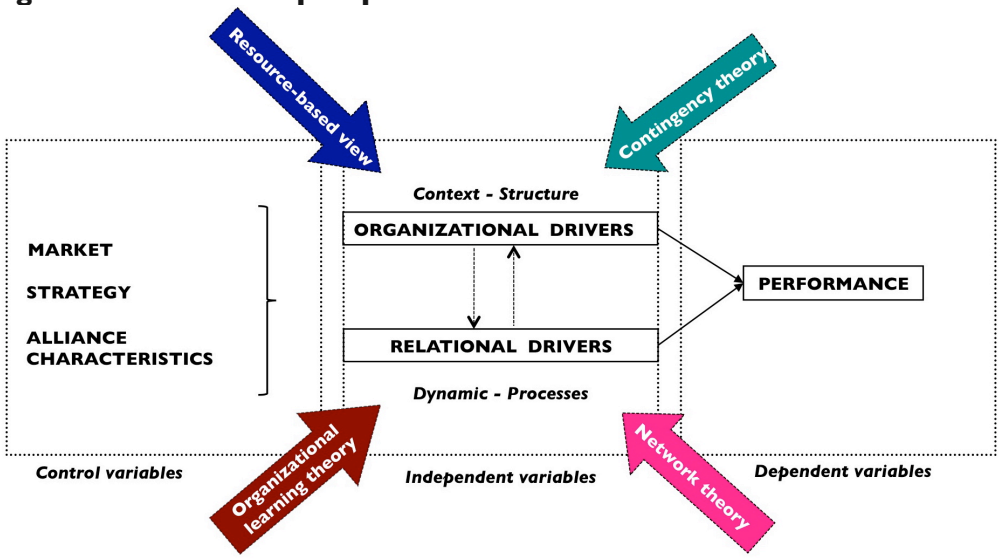
Finally, implementing co-innovation requires new competences, such as the ability to develop relational capital with externals, and an open organizational culture that includes a "Proudly-Found-Elsewhere" mentality, as will be discussed in the following chapters.

3. THEORETICAL PERSPECTIVES

3.1 INTRODUCTION

In this chapter, we discuss four perspectives in general, which serve as the basis for our co-innovation COINN model: network theory, contingency theory, organizational learning theory, and resource-based view. We discuss the key concepts of these theories and their impact on co-innovation performance, as is illustrated in Figure 3.1. We concentrate on the factors and processes that can be derived from the literature in order to diagnose and manage co-innovation alliances.

Figure 3.1: Research perspectives of the COINN model



In the section on network theory, we define several aspects of ties (strong versus weak, direct versus indirect ties, and structural versus personal ties). We discuss differences between a closed and an open network, and the concept of structural holes, and place these concepts in the co-innovation context. In the section on resource-based view, we define core competences, dynamic and combinative capabilities. We explain the differences between competences, capabilities and abilities, and discuss facilitating and blocking factors in competence development. In the section on contingency theory, we discuss the concept of fit in general, and the effects of a market, strategy, resource, organization and culture fit on the performance of co-innovation alliances. The organizational learning theory is one of the pillars of our COINN model. We also discuss absorptive capacity, combinative capability, cognitive distance and the

paradoxes of information and replication. We explain different types of knowledge and the accompanying processes of learning, and discuss facilitating factors and difficulties for organizational learning in co-innovation alliances.

The literature review serves at least two purposes. We will make an inventory of concepts of relevant constructs in order to build our COINN model, including the use, limitations and relationship to performance, and in the literature search we will select validated questions that might be relevant to our questionnaire (Netemeyer et al., 2003).

We motivate our choice of theoretical perspectives as follows. We select network theory because co-innovation involves by definition relationships with external parties, and - as discussed in Chapter 2 - networks play an increasingly important role in competition. Assessing whether the competences of partners in the co-innovation alliance are and remain up to standard is a vital element in selecting and evaluating partners. Describing companies in terms of bundles of competences, which is the perspective of the resource-based view, is therefore relevant. In addition, competences should fit with one another: for alliance performance, a fit between the alliance partners, or between the alliance and the environment, is essential, which can be analyzed through the lens of contingency theory. A fit however, is a *conditio sine qua non* but not sufficient. A company can only benefit from its co-innovation alliance if it is able to acquire, process, and use additional knowledge effectively. We select organizational learning theory in order to understand the internal processes.

In addition to the four theoretical perspectives, we observe research regarding the performance of adjacent organizational forms, such as joint ventures, (strategic) alliances, and international networks, which have been researched extensively in many different industries, regions and time frames. The results of these studies are of importance to co-innovation alliances.[1] Some of the studies observe aspects, such as conflict resolution, trust or organizational culture; others explain time-effects or causal-effects, which have a bearing on stability, survival, or failure (Parkhe, 1991; Doz, 1996), as summarized in several meta-studies.[2]

[1] One of the perspectives of alliance research is the transaction cost theory (Nooteboom, 1999; Madhok and Tallman, 1998; Park and Ungson, 2001; Glaister and Buckley, 1996; Park and Russo, 1996; Ring and Van de Ven, 1994; Parkhe, 1993a; and Kogut, 1988). Because of the focus of our research, we do not discuss this theory separately, but add its contribution where relevant in the next chapter on the COINN-model.

[2] See: Koza and Lewin (1998), Eisenhardt and Martin (2000), Park and Ungson (2001), Ireland et al. (2002) and Heimeriks (2005).

3.2 NETWORK THEORY

Network theory has been used to explain alliance performance in many research projects,[3] and sometimes combined with organizational learning[4] or contingency theory (Gilsing et al., 2007). Especially the effects of a social network (social capital) on inter-organizational relationships have been discussed frequently.[5]

As mentioned before, networks are increasingly important in creating competitive advantage and boosting innovation performance: a network, with its greater diversity of knowledge, is more effective than an individual firm at generating, transferring, and combining knowledge; a network facilitates knowledge transfer among members (Dyer and Nobeoka, 2000), and therefore, firms that are embedded in networks are likely to achieve a better innovative performance (Pennings and Harianto, 1992; Powell et al., 1996; Ahuja, 2000a; Baum et al., 2000). Especially for young companies, cooperating with others is essential (Shan et al., 1994; Baum et al., 2000). In addition, through information networking, a company can obtain more influence in an industry (Zaheer and Zaheer, 1997). Some key elements of network theory, listed in box 3.1, will be discussed in the following.

Box 3.1: Aspects of network theory

1. *Strong and weak ties*
2. *Direct and indirect ties*
3. *Closed and open network*
4. *Structural holes*
5. *Structural ties and personal ties*

Strong and weak ties do not describe the intensity of relationships, but the social structure that surrounds them: two people share a strong tie when they have mutual contacts and a weak tie when the contacts are not connected in any way. Strong ties are beneficial for existing groups, and weak ties for new groups. Through strong ties, current information flows readily within an existing group

[3] See: Blankenburg Holm et al. (1996), Dyer and Singh (1998), Gulati (1999), Gulati et al. (2000), De Man and Duysters (2002), Koka and Prescott (2002), Goerzen and Beamish (2005), and Laursen and Paulsen (2006).
[4] See: Gulati (1999), Stuart (2000), and Hagedoorn and Duysters (2002).
[5] See: Oliver (1990), Gulati (1995), Powell at al. (1996), Walker et al. (1997), Osborn and Hagedoorn (1997), Inkpen and Dinur (1998), Kraatz (1998), Madhavan et al. (1998), Tsai and Ghoshal (1998), Gulati (1999), Ahuah (2000), Baum et al. (2000), Dyer and Nobeoka (2000), and Kale et al. (2000).

and weak ties encourage new information (Dyer and Nobeoka, 2000). Gilsing and Duysters (2008: 704) conclude that originality is created by a combination of both weak and strong ties; the weak ties serve as bridge in the acquisition of new knowledge, while the strong ties enable absorption of new knowledge within the alliance. Weak ties facilitate access to *new* knowledge from outside, but complicate the transference of *complex* knowledge internally, for which strong ties are required (Hansen, 1999).

The concept of *direct and indirect tie*s is important. In a direct tie connection, two companies are directly related to each other, which is not the case with an indirect tie. A direct tie has the advantage of potential resource sharing, while indirectly tied relationships might offer more opportunity for capturing knowledge spillovers (Ahuja, 2000a). Indirect ties may serve as a 'radar' for companies by sensing new developments, which are especially useful in explorative learning (Beerkens, 2004).

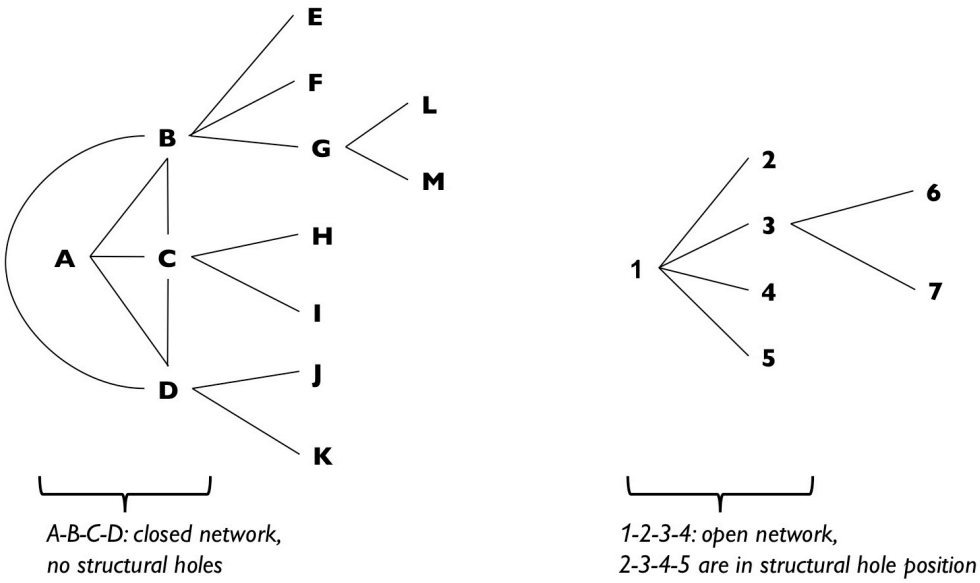
We distinguish *closed and open networks*. In a closed network, all partners are connected, contrary to an open network, where only some of the partners are linked to one another. In open networks, partners have outside network relationships, which are not shared by their partners.

Burt (1992) defined the degree of connectivity, known as the *structural hole*. People who hold a brokerage or *structural hole* position, are the sole link between different groups, and may benefit from their unique position, whereas when not in such a position, they have access to different, non-sharing flows of information. Structural hole positions can be exploited. It is therefore important to recognize such positions, because of the potential advantages, or disadvantages such as over-dependency on partners (Walker et al., 1997; Ahuja, 2000a). A gap may arise in a larger network if individuals or organizations when structural hole-positions are moved within a network (Hargadon, 2003), structural holes are therefore crucial in the management of inter-organizational relationships.

The fact that networks consist of *structural ties* (formal relationships between organizations) and *personal ties* (personal relationships between social actors) is worth mentioning. These ties interact with one another. When managers have good personal relationships, they tend to form structural ties as well. The sum of all personal ties is known as the social capital of a company. Social capital enables firms to access and capture the embedded resources in their social relations (Gilsing et al., 2007) and is considered to be a good indicator of future cooperation: firms with higher social capital are likely to have more relationships with new partners. Apart from this, the more relationships a firm has, the more likely it is that its social capital will increase (Walker et al., 1997), which will have a

positive impact on the trust and cooperation within the network (Gilsing et al., 2007). The differences between the above mentioned ties are illustrated in Figure 3.2: firm A has direct ties with firms B, C, and D. Firm 1 has direct ties with firms 3, 4, and 5. Firm A has indirect ties with Firms E through M, and firm 1 with firms 6 and 7. Firm A forms a closed network with its partners B, C, and D. In a closed network, all are tied to each other, with no structural holes (from Firm A's perspective). Firm 1's partners are not connected to each other, creating an open network with structural hole positions for partners 2, 3, 4, and 5.

Figure 3.2: Direct ties, indirect ties and structural holes



Source: Ahuja (2000a).

Which factors are productive for co-innovation result, and which ones are counter-productive? At least ten items, listed in box 3.2, are relevant for alliance performance.

Box 3.2: Contributing elements of network theory

1. *Aim of networking*
2. *Size of the network and its partners*
3. *Diversity of a network and interdependence of its partners*
4. *Structure of a network*
5. *Context of a network*
6. *Intensity of a network*
7. *Position of a partner within a network*
8. *Networking capabilities*
9. *Balance between structural and personal embeddedness*
10. *Dynamism of networks*

The *Aim of networking* is paramount to co-innovation alliances, as it depends on the strategic motivation of a firm and influences the level of desired coordination within the alliance.[6] The optimal structure of inter-firm networks depends on the objectives or aims of the network members (Ahuja, 2000, Gilsing et al., 2007). If networking is used as a source of knowledge and learning, network membership will lead to more information transfer and learning, a larger knowledge base or improved process and product innovation (Beckman and Haunschild, 2002; Caloghirou et al., 2003). This learning effect however, depends on the type of knowledge that the partners strive to obtain. This type of knowledge determines the optimal type of network – for example, an open or closed network. We will discuss the types of knowledge later in the section concerning organization learning.

The *size of the network* and its partners contributes to explaining the performance of co-innovation alliances as it influences the embeddedness of a firm[7]. To a certain extent, a larger number of direct ties offer a higher innovation output, because of the opportunity to share more knowledge, or to gain economies-of-scale advantages (Ahuja, 200a). A small or very large network is usually less successful (Vanhaverbeke et al., 2001): the added value of a very small network is not substantial enough, while the very large network might suffer from many internal stresses due to divergence of the different partners (Baum et al., 2000). An exception is an R&D network, in which the size and diversity (even with potential

[6] Aim of networking is used to construct the *strategy control variables* in section 5.6, see: box 5.4, and the independent variable *Control need*.

[7] *Size of an alliance* serves as a control variable and *Embeddedness* as a independent variable in our COINN-model.

rivals) has certain advantages in accessing new knowledge. however, due to complex coordination and decision making, the higher the number of direct relationships in the knowledge network, the longer the project completion time (Hansen, 2002). The sizes of network partners should fit with the internal knowledge base[8]: especially young and small firms benefit from large, innovative partners (Stuart, 2000). Companies with a large internal knowledge base usually seek a small external knowledge base via alliances, while companies with small internal knowledge bases put more emphasis on building up an external knowledge base via networking. The combination of alliance partners that have a large and internal knowledge base and that strive for a large external knowledge base, tends to be less stable. The same applies to situations involving alliances of partners with small internal knowledge bases striving for small external knowledge bases. Another problematic network combination, due to the higher possibility of conflicts of interest, is a network with companies that have global, fully integrated strategies (Gomes-Casseres, 1989). The size of a network is also important for the intent to perform: the likelihood that a partner fulfils its objectives is higher in a small (dyadic) alliance than in a large (multi-partner) alliance (Garcia-Canal et al., 2003).

The *diversity of a network and interdependence among its partners* is important as it influences the embeddedness of a firm.[9] Organizations build ties with other organizations that have complementary resources and capabilities, but also take into consideration the position the potential partners have in the social structure of the network. This is known as structural differentiation (Gulati and Gargiulo, 1999). Knowledge heterogeneity may lead to more impact on performance, because the different competences of the alliance partners add value substantially. This heterogeneity however, also has disadvantages, because the communication between partners is more difficult and consequently, the probability of conflict and turnover is higher (Goerzen and Beamish, 2005). Here, technological distance (Gilsing et al., 2008) or cognitive distance[10] (Nooteboom, 1999a) is relevant. Interdependence between partners and their embeddedness in networks have a significant and positive impact on the decision to start new alliances, because companies rely on their network partners to determine whether and with whom they could cooperate (Gulati, 1998). Companies also modify existing networks by beginning new alliances. If companies are interdependent, they tend to form more alliances with each other (Gulati and Gargiulo, 1999). Within a network with

[8] *Size* of the focal firm and its partners, both in absolute terms as well as relative to one another, serve as a control variables in our COINN-model.
[9] These items are used to construct the independent variable *Embeddedness*.
[10] To be explained later in the organizational learning section.

much structural differentiation, relevant information concerning competencies, needs, and reliability of potential partners can be processed more easily. Such a network facilitates the identification of complementary and reliable partners, and thus reduces the risk of cooperating with new partners.[11] The higher the structural differentiation of a network, the more organizational decisions concerning new partnerships are guided by considerations of the existing network compared with the considerations of exogenous factors. A differentiated network structure implies that more information is available to the network. At the same time however, it reduces the range of potential alliance partners, who might be invited to enter the alliance (Gulati and Gargiulo, 1999). The diversity of a network has an effect on the speed of implementation; if knowledge can be obtained directly from other chains in the network (due to a shorter path) or when knowledge can be codified (in case network diversity is limited), projects can be completed more rapidly. In addition, if partners in a network are mutually interdependent and directly linked, we can expect higher product quality and faster time-to-market (Dyer and Nobeoka, 2000; Hansen, 2002).

Another contribution of network theory deals with the *structure of a network*, which is affected by similarities in the strategic capabilities, their strategic linkages, or in the complementary nature of the firms (Nohria and Garcia-Pont, 1991; Vanhaverbeke and Noorderhaven, 2001). The structure of a network influences the level of embeddedness as well. Networks consist of internal (intra-firm) and external (inter-firm) linkages. External linkages can be further separated into rational (strategic) and relational linkages. The choice of these is influenced by cultural diversity.[12]

The *context of a network* is of significance to co-innovation alliances because context influences the choice of network strategies by determining the optimal number of ties and the density of a network (Powell et al., 1996; Rowley el al., 2000; Vanhaverbeke and Noorderhaven, 2001).[13] On the one hand, in a dynamic environment, firms tend to have more learning-based motives in their networks, and are especially focused on explorative or non-routinized learning[14] (Hagedoorn and Duysters, 2002b). On the other hand, in a static environment, firms

[11] The item complementary partnerships is used to construct the independent variable *Balanced competences*.
[12] For instance, Taiwanese companies tend to start strategic linkages with investments in the United States, while they form relational linkages in Southeast Asia and China. Small firms are more sensitive to relational linkages than large firms in their choice of investment location (Chen and Chen, 1998).
[13] Context of a network is used to construct the control variables concerning *market conditions*, see: Section 5.6, Box 5.3.
[14] This learning involves changes in company routines and experimentation with new alternatives.

concentrate on efficiency in their networks and are selective when networking. In these cases, learning is focused on exploitative or routinized learning, which adds primarily to the existing knowledge and competences of a firm.

The *intensity (or density) of a network* influences innovative performance as networks can be categorized into weakly or highly interconnected. As discussed earlier, strong-tie networks are better suited for the diffusion of existing knowledge, while weak-tie networks are preferable in the case of co-innovation, where exploration of new knowledge is important. The number of a firm's direct ties however, moderates the effectiveness of indirect ties: the greater the number of direct ties, the smaller the benefit from indirect ties, because in this case, companies are more strictly limited in profiting from their indirect ties (Ahuja, 200a; Gilsing et al., 2007). The intensity of a network correlates positively with innovative performance and is determined by interpersonal relations and management involvement, as discussed in the next chapter.[15]

The *position of a partner within a network* is significant to co-innovation alliances - e.g., in determining the level of embeddedness of a firm.[16] Companies manage co-innovation differently when their positions within an innovation system vary. The extent to which a partner is occupied in a network and the prominence of its position is known as *positional embeddedness* (Gulati and Gargiulo, 1999).[17] The greater the differences of tasks and roles in a network, the more important the various partners are. In other words, large structural differentiation also implies more positional embeddedness. Companies with greater network centrality benefit more from the network and may achieve faster growth (Powell et al., 1996; Tsai, 2001; Bekkers et al., 2002), because they have more and better contacts with the key players within the network. This effect however, depends on a firms' ability to successfully replicate new knowledge (Tsai, 2001).[18] Key partners provide firms with easier access to complementary capabilities and specialized knowledge, enabling them to lower the overall coordination and production costs. As a result of this, the network as a whole might also benefit (Lorenzoni and Lipparini, 1999). In co-innovation alliances, companies with different positions within a network cooperate with one another. For example, experts who have a unique distinctive technology, cooperate with large firms, that have complementary competences, such as marketing know-how or access to distribution channels.[19] Different

[15] *Interpersonal relations* and *Management involvement* serve as independent variables in our COINN model.
[16] See: the independent variable *Embeddedness*.
[17] See: the independent variable *Interpersonal relations*.
[18] Known as *absorptive capacity*, see: Box 3.7 in Section 3.5 on *organizational learning* or Section 4.4.3 on *technology transfer*.
[19] See: the independent variable *Balanced competences* in the COINN model.

positions in networks insure that the interplay is highly desirable though more complex (Christensen et al., 2005). Networking may raise the value of future business relationships.

Networking capabilities contribute to the performance of co-innovation alliances - i.e., the capabilities of a firm to develop and utilize inter-organizational relationships (Walter et al., 2006). Such networking capabilities can be built up through experience: the greater the extent of a firm's network resources derived via prior networks, the greater the likelihood of entering into a new network (Gulati, 1999).[20] In addition, these capabilities are dependent on interpersonal relations and management involvement.[21]

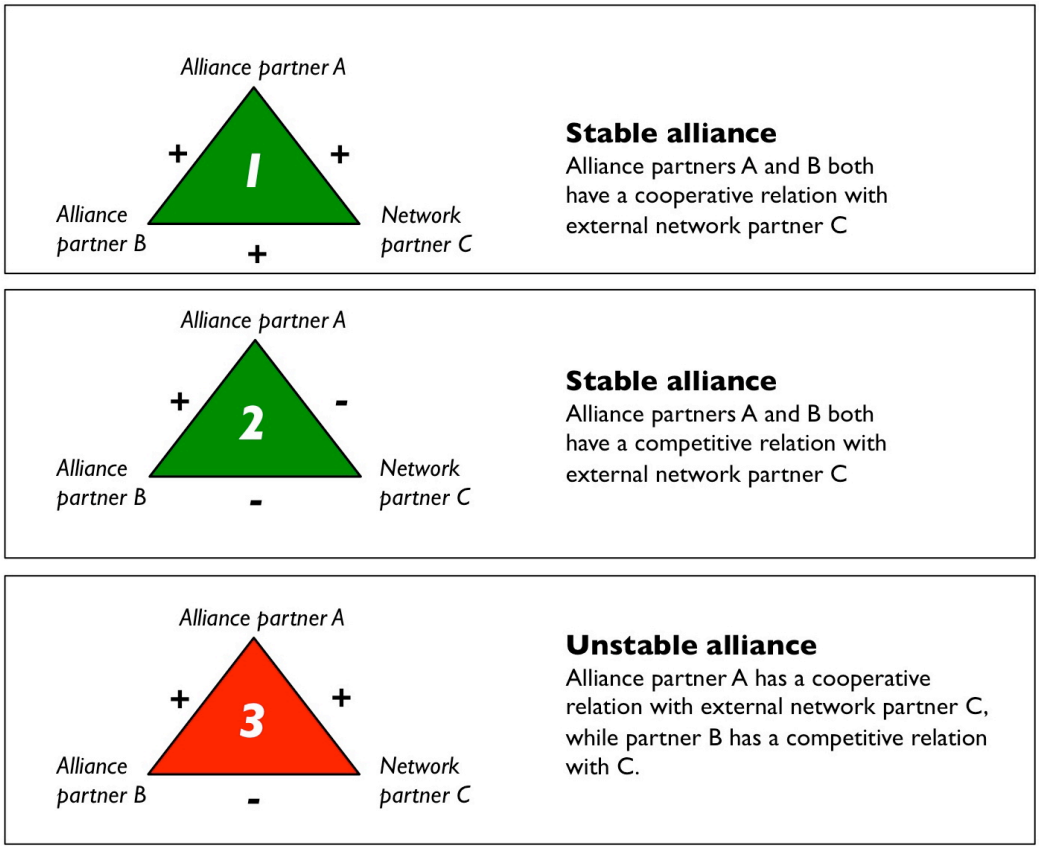
Another contributing factor consists of a *balance between structural and personal embeddedness*. We will discus, management involvement and interpersonal relationships in the next chapter in the sections on trust. Personal ties between gatekeepers or boundary spanners play a major role in the maintenance of inter-organizational cooperation. The so-called *boundary spanners* are people who scan and interpret the environment, and then pass on information to the rest of the organization (Hansen, 2002). A certain personal chemistry or emotional attachment is essential. Such relation-based attachment may also lead to individual gains (Das and Teng, 2002), gaining "fine grained information" (Gulati, 1998:296) or competence development (Andersson et al., 2002). A balance between individual and structural embeddedness between partners stabilizes alliances (Seabright et al., 1992; Madhok, 1995a; Child and Faulkner, 1998).

D*ynamic aspects* of networks are relevant to co-innovation alliances, and will therefore be included as a control variable in our COINN model.[22] Networks evolve gradually - for instance, from a collection of dyadic-weak ties to a web-like structure with stronger ties, which affects the relationships within alliances. Within all inter-firm cooperative relationships, certain elements of cooperation and competition can be detected simultaneously (Bell, 2003). Companies adapt their strategies and activities to the changing environment.[23] Consequently, non-competing partners may become rivals. Partners may enter or leave the alliance. Participation in networks influences the behavior of firms that are within and others that are outside the network (Gulati et al., 2000).[24] Multi-lateral alliances,

[20] Experience is part of the independent variable *Embeddedness*.
[21] See: the independent variables *Interpersonal relations and Management involvement*.
[22] See: in Section 5.6, Box 5.3, the control variables *Market life cycle* and *Market turbulence*.
[23] This insight is used to define the strategy control variables *Flexibility* and *Stability*, see Section 5.6, Box 5.4.
[24] One of the motives to form an alliance is the ability to influence the networking activity of the partners, such as placing constraints on ties with others, known as lock-in and lock-out effects.

where firms are both competing and collaborating, tend to evolve into several more stable coalitions which compete with one another. Networks that are unstable, may break down in order to form more stable substructures (Doz and Hamel, 1998). The balance between collaboration and competition within an alliance also depends on the relationship of the alliance partners with third parties, which might complicate the alliance, as illustrated in Figure.

Figure 3.3: Effect of outside networks on alliance stability



Source: Gomes-Casseres (1996).

In this figure, A and B are alliance partners. Both have relationships with external party C. If C cooperates with both A and B or competes with both, the alliance is balanced, but if C cooperates with only one of the alliance partners, and competes with the other, the alliance is unbalanced (situation 3, as illustrated in Figure 3.3). In situation 3, A can play different roles: it can mediate between B and C, it may dominate because the others compete or it might play a divide-and-rule game (Gomes-Casseres, 1996).

In conclusion, ties in networks are much closer. The character of a relationship between external partners and their attitude towards each other differ in embedded vis-à-vis stand-alone situations. Partners tend to act less egoistically and are more oriented in the long run. Furthermore, they act with more loyalty and trust, and will not change sides overnight. Relationships in embedded situations are more personal, and differ from relationships with individually acting companies. Individually acting companies merely exchange information concerning prices, while network partners exchange information on many more issues. Firms with embedded relationships are more inclined to solve their problems jointly (Uzzi, 1997)

Different ties tend to offer different advantages. Direct or indirect ties and connections between partners may influence a firm's innovation performance, by offering resource-sharing (direct ties) and knowledge spillover benefits (direct and indirect ties). Even though most firms are becoming increasingly embedded within alliance networks, not all perform well (Vanhaverbeke and Noorderhaven, 2001). In assessing potential alliance partners, it is therefore relevant to assess the networks of the partners. Furthermore, because the ways and means by which networks are managed are not always clear, it is important to involve them in the assessment as well (Devinney et al., 2000; Goerzen, 2005).

3.3 RESOURCE-BASED VIEW

The resource-based view was initiated by Penrose (1959) and has become one of the most influential frameworks in the strategic management literature. The resource-based view complements and integrates contributions from several perspectives - e.g., industrial organization and transaction cost theory. The contribution of the resource-based view in explaining alliance performance has been summarized in several studies (Peteraf 1993; Teece et al., 1997; Sanchez, 2001; De Man and Duysters, 2002; Goerzen and Beamish, 2005; Lavie, 2006).

In the resource-based view, firms are seen as bundles of resources, which to a greater or lesser extent are specific to the firm. These resources are *"valuable, rare, imperfectly imitable and imperfectly substitutable"* (Maijoor and van Witteloostuijn, 1996: 550). Other firms cannot instantly copy them because they are difficult to imitate. Core competences[25] are bundles of skills and technologies

[25] Sometimes called capabilities (Doz and Hamel, 1998). We consider capabilities and competences synonymous.

that form critical sources of competitive advantage and corporate identity (Spekman et al., 2000; Ulrich and Smalwood, 2004).

We summarize some relevant aspects of competences to co-innovation alliances in box 3.3.

Box 3.3: Aspects of competences

1. *Tangible or intangible aspects*
2. *Development and utilization*
3. *Static and dynamic*
4. *Technical and social aspects*
5. *Organizational and personal level*
6. *Internal and external acquisition*

Resources can be *tangible* – such as land or machines - or *intangible*– for instance, knowledge, tacit know-how, brand names, managerial systems, and organizational culture (Leonard-Barton, 1992; Nooteboom, 2000).[26]

In addition to *developing* competences, the *utilization* of competences is important. Some researchers concentrate on the development of competences by emphasizing the origin, acquisition, maintenance and erosion of a firm's capabilities by viewing them as a basis for developing new resources (Mowery et al., 1998; Combs and Ketchen, 1999). Others stress the utilization of competences, by taking into consideration that firms try to capture value from them; in this case, a competence is viewed as a firm's ability to use and exploit resources economically (Bell, 1996).

The distinction between a *static and dynamic view* of competences is paramount. Initially, the resource-based view did not involve dynamic aspects. Later, the resource-based view has been extended to the dynamic capabilities view by adding dynamic aspects of resource access, thus creating capability, and learning in changing environments. In order to be able to cope with changing environments, the dynamic capabilities view focuses on a firm's ability to integrate, build and reconfigure internal distinctive competences, and combine them with external competences (Kogut and Zander, 1992; Teece et al., 1997; Teece, 2007).

Competences have both a *technical and a social* aspect. Technical competences are for instance, the functional expertise in manufacturing or developing new products. Social competences are for example an organizational

[26] In the section concerning organizational learning, we describe that tangible and intangible resources interact with each other.

culture of open mindedness towards new developments or an individual ability to influence and persuade external alliance partners. For instance, Gulati (1995b) provides empirical support for the importance of a social network in alliance formation.

Organizational and personal competences differ from one another. In the resource-based view, most competences are considered at the organizational level. Because our research involves implementation, individual competences should be considered as well. Bailey et al. (2001: 5) define individual competences as sets of behavior that are instrumental in the delivery of desired results. Individual competences reflect a person's ability to apply knowledge, understanding, and skills resulting in the required performance standard, which includes problem solving, meeting changing demands, or a person's potential for development.

In addition to the *firm-specific* development, competences can be developed through *external* partners. One of the basic reasons that firms cooperate with one another, is that they depend on the critical complementary competences of others, which cannot be developed readily or sufficiently rapidly on their own (Child and Faulkner, 1998; Nohria and Garcia-Pont, 1991; Nooteboom et al., 2007). Firms compare their competences with the technological portfolios of potential partners. Through partnering, companies can develop and generate their core competences or gain critical mass for certain resources (Ahuja, 2000b; Gulati et al., 2000; Caloghirou et al., 2003). By employing complementary resources, the alliance partners can improve their competitive position. Even though a firms' competence may initially be complementary, they may end up as rivals. (Das and Teng, 1998; Khanna et al., 1998; Park and Ungson, 2001; Lambe et al., 2002).

Some factors facilitate the development and use of competences, others complicate it, as listed in boxes 3.4 and 3.5.

Box 3.4: Facilitating factors in the use of competences

1. *Internal sources: experience and specialization*
2. *Development via selection, training and coaching*
3. *External cooperation*

One way of developing capabilities is through the accumulation of *experience*.[27] In order to benefit from experience, it should be bundled, sorted, integrated and diffused (Cohen and Levinthal, 1990; Levinthal and March, 1993;

[27] Experience is included in the independent variable *Embeddedness*.

Eisenhardt and Martin, 2000; Kale et al., 2002; Bell, 2003).[28] We discuss evaluation mechanisms in section 4.4.3. on *transfer of technology*. In addition, organizational capabilities may be developed through the *selection* of new personnel with the required competences, or the *training* and *coaching* of existing personnel (Bartram, 2005, 2006; Stober and Grant, 2006).[29] Furthermore, firms strive to achieve an appropriate mix of current core competences and at the same time additional partner competences.[30]

Several complicating factors of developing and utilizing competences can also be listed, see box 3.5.

Box 3.5: Complicating factors in the use of competences

1. *Tacit knowledge*
2. *Dynamic circumstances*
3. *Protected knowledge*
4. *Core rigidities*

Some intangible competences involve tacit knowledge, which is difficult to describe, and thus a complication in the process of transfer of technology or claiming and commercializing property rights (Nooteboom, 2000).[31]

Another complicating factor is the fact that a firm's resources only develop gradually. In times of external turbulence, companies may therefore not be able to acquire new abilities quickly enough[32]. In this case, other sources might be necessary - such as a co-innovation alliance (Levitt and March, 1988; Ghoshal and Gratton, 2002; Bell, 2003). Duysters and Hagedoorn (2000a) conclude however, that in the short-term, only market knowledge may be acquired through external partners; external sources might not be an appropriate means of developing new core competences in the short-term either.

In addition, companies might consider certain knowledge as strategic, and consequently have the tendency not to share it with external partners. When knowledge is protected, partners do not have access to it[33].

[28] To be discussed further at the organizational learning Section, 3.5.
[29] To be discussed further in Chapter 7 (Summary and conclusions).
[30] Additional partner competences are included in the independent variable *Balanced competences*.
[31] The aspect of tacit knowledge is included in the independent variable *Transfer of technology*.
[32] See in Section 5.6, Box 5.3, the control variable: *Market turbulence*.
[33] Relevant to the independent variables *Trust, Culture fit,* and *Technology transfer*.

Last, traditional core competences might evolve into *core rigidities* when they become counter-productive – e.g., due to changing market forces.[34] Those competences were initially the basis for corporate success, therefore companies are reluctant to abandon or change them, even if they become counter-productive. In the case of core rigidities, a redefinition of core capabilities is required or new competences should be acquired (Moss Kanter, 1989; Leonard-Barton, 1992; Hamel and Välikangas, 2003; Christensen et al., 2004). This is especially relevant to co-innovation, where traditional systems, skills or values of the partners may be inappropriate. Co-innovation is usually conducted in dynamic and uncertain markets where it is essential to highlight the need for change and therefore act deliberately and proactively towards corporate renewal. Co-innovation alliance partners should give enough attention to their organizational cultures by enabling organizational renewal. (Govindarajan and Trimble, 2005; Trompenaars, 2007).

In conclusion, with the resource-based view it remains unclear *how* a firm can develop new alliance capabilities. In order to meet this shortfall, we include organizational learning theory in our analysis. We discuss the ability of a firm to learn from new information, known as *"absorptive capacity"* which is considered to be an important source of competitive advantage[35] (Ghoshal, 1987; Cohen and Levinthal, 1990; Kale and Singh, 2007). In order to manage a co-innovation alliance properly in an efficient and effective way, specific alliance competences are essential. These competences include social, technical, individual, and organizational aspects. Besides alliance management, knowledge management is necessary in order to benefit from the results of the co-innovation alliance, which involves the capture, dissemination and use of such knowledge (Eisenhardt and Martin, 2000; Heimeriks and Duysters, 2002a; Ulrich and Smallwood, 2004).

3.4 CONTINGENCY THEORY

Contingency theory assumes the existence of an optimal compatibility, or fit, between constructs - e.g., a fit between a market environment, and a specific business model, governance structure, leadership style, and organization form (Strebel, 2003). Researching the concept of fit is in itself, not new (Chandler, 1962; Lawrence and Lorsch, 1967; Porter, 1980; Mintzberg, 1983). Several researchers have summarized the impact of contingency theory on alliances (Hill and

[34] This item is relevant to the independent variables *Culture fit* and *Technology transfer,* and the strategy control variables *Flexibility* and *Stability*, 4.
[35] To be discussed further in the organizational learning Section 3.5.

Hellriegel, 1994; Nohria and Ghoshal, 1994; De Man and Duysters, 2002; Douma et al., 2000; Garcia-Canal et al., 2003; Goerzen and Beamish, 2005). The added value of contingency theory to our research on co-innovation alliances can be found in the identification of the drivers of fit and their consequences on performance. It is known that a *strategy fit*, an *organization fit* or *external fit* - the degree of congruence between strategy and its external and internal context - significantly correlates with performance (Lin and Germain, 1998; van Witteloostuijn et al., 2008). Misfits can be considered as potential failure factors, causing a lower success rate or underperformance of the co-innovation alliance.

Below we will discuss the concepts of *market fit, strategy fit, resource fit, and culture fit* as contingencies that are relevant to co-innovation alliances.

Market fit[36] is the congruence between the market environment and organizational form, leadership style, or governance structure of companies. In situations of high complexity and resource scarcity, more collaboration is desirable and the intent to ally will be increased. Consequently, partners will be committed to the co-innovation alliance, provide more resources, and be more determined to reach the alliance goals, resulting in a better performance. Environmental complexityhas an impact on the way in which the partnership should be managed effectively, and on the most appropriate leadership style: a dynamic or uncertain market requires a more flexible structure.[37] In this situation, we can expect that a highly detailed contract will hinder both innovation process and the outcome. Furthermore, in the early development stages of markets, we can expect business models that are less integrated in the formal structures of the alliance partners because, in this case, the primary focus is on innovation; standardized routines to increase efficiency are less relevant (Strebel, 2003). The market also has an impact on appropriate leadership styles; in situations of low urgency for change and low resistance to change, a different leadership style should be chosen (chairman or coach) vis-à-vis situations of high urgency and high resistance (commander). Environmental complexity also has an impact on the way in which the partnership should be managed effectively; in early development stages, we can expect business models that are less integrated in the formal structures of the alliance partners. In this case, the primary focus is on innovation; standardized routines to increase efficiency might be counter-productive (Strebel, 2003). Different environmental circumstances lead therefore to different organizational structures and leadership styles. In many cases, the markets of co-innovation are in the early stages of

[36] We consider this synonymous with environmental fit.
[37] See: the market control variable *Market complexity* and the strategy control variable *Flexibility*.

development with high technological complexity and dynamism, implying the need for a flexible organization, which is not necessarily integrated in the formal structures of the alliance partners. At the same time, these circumstances demand leaders who are able to deal with uncertainties, and can persuade business partners to cooperate. We include several market conditions as control variables in our model.

A *strategy fit* describes how well a firm and its partners are aligned strategically (Slowinsky and Sagal, 2003). A strategy fit between alliance partners exists when the strategic drivers of the alliance partners match and do not conflict, which implies a shared vision and a compatibility of strategies. A good basis for cooperation exits when partners have a good strategy fit (Brouthers et al., 1995; Douma et al., 2000). In cases of a limited strategy fit, the commitment of the partners to resolve potential conflicts will be lower, causing the cooperation to dissolve when unforeseen obstacles arise. In co-innovation, it is important to be able to judge whether the strategic drivers of the partners fit. When do technological, strategic and financial goals of the partners match one another? Can flexibility be expected in unforeseen circumstances? Will partners remain committed to the partnership? *Strategy fit* also serves as control variable in our model as well.[38]

In the case of a *resource fit* between alliance partners, the resources of the alliance partners are complementary to one another: partners need each other to fulfill the alliance task – in our context -, in order to innovate. We therefore, use *resource fit* to construct our independent variables *balanced competences*, *coordination need* and *management involvement*. Changes that disturb the exchange resource fit between partners, might lead to the dissolution of the alliance (Dyer and Singh, 1998; Gulati, 1999; Porter, 1980; Slowinski and Sagal, 2003). We will evaluate the resource fit between partners empirically and view its relationship to co-innovation performance in the next chapters.

An *organization fit* facilitates alliance success and determines whether an alliance is feasible. An *organizational fit* between alliance partners enables effective management control or decision authority (Johnson et al., 1996; Dyer and Singh, 1998; Douma et al., 2000; Kale et al., 2000). We will evaluate the impact of *organization fit* on co-innovation performance empirically in the next chapters, especially in the sections on *contract* and *coordination need*.

A *culture fit* has an impact on the appropriate organization type: socio-cultural distance - a fit between national cultures, or organizational cultures - is one of

[38] See: the strategy control variables *Strategic, technological and cost saving motives*, *Flexibility*, and *Stability*.

the factors which leads to the decision to ally or not (Agarwal, 1994). We will assess the extent to which partners have a *culture fit* in the following, and assess the influence on co-innovation performance.

In conclusion, different circumstances lead to different fits. Companies should be prepared to differentiate their policies towards differing circumstances, known as a *differentiated fit*, because the fit should be differentiated per organizational part, including the external network of a firm (Nohria and Ghoshal, 1994; Andersson et al., 2002).

Furthermore, fits change in the course of time. Markets of co-innovation alliances usually change rapidly and the traditional concept of fit is too rigid, therefore a more dynamic view should be considered (Douma et al., 2000). A sure fit can easily become a misfit. At the same time, a suboptimal relationship between partners may improve, provided that the partners can adapt, are flexible, and have the capacity to manage the dynamics effectively (Doz, 1988).

A fit between partners does not necessarily mean similar inputs of the partners in co-innovation alliances; especially where creativity or innovation is vital, diversity to a certain extent, will be functional, because it enriches idea generation and decision-making (Kirton, 2003).

Several fits should be achieved simultaneously; matches between the strategic drivers of partners in a network, the positions these partners have in their industries, the organizations and cultures are important. A situation with multiple fit leads to a more stable alliance, while a multiple misfit may have a negative impact on performance.[39]

3.5 ORGANIZATIONAL LEARNING

In organizational learning theory, the central issue is *how* firms can learn. Knowledge has become the most important resource for firms (Gassman, 2006: 224), consequently, competing for knowledge factors has become increasingly important, especially in the case of innovation. The ability to create new knowledge is increasingly becoming a priority for top management (De Geus, 1997a,b), although the relevance of learning is dependent on the turbulence of the environment (Inkpen, 1995): the more turbulence, the more the ability to learn

[39] Doz and Hamel (1998) describe an example of an alliance of an industry leader and his challenger. Such an alliance is only viable if partners obtain specialized positions in the alliance. Otherwise, such a combination may lead to rivalry between the alliance partners, resulting in less stability and underperformance.

becomes a necessity. In order to learn from their environment, firms should focus on relevant developments in their environment. Structured attention therefore is necessary towards designated employees who are able to develop new ideas and put them into practice (De Geus, 1997a,b). New technologies should be identified globally, made accessible, assimilated, transformed and exploited in order to develop and market new products which involves the organizational learning processes of sensing-mobilizing-optimizing.[40]

Organizational learning is a multi-dimensional construct and must be viewed from a number of perspectives simultaneously, for instance through the cognitive change and behavioral change lenses between different accompanying management roles (Levitt and March, 1988; Huber 1991; Inkpen, 1995; Bell et al., 2002). The contribution of organization learning theory, which gives insight into alliance performance, has been summarized in a number of studies (De Man and Duysters, 2002; Goerzen and Beamish, 2005).

Box 3.6: Sharing knowledge

"Unlike most assets, organizational knowledge can actually grow when shared"

Source: Inkpen (1998: 75).

Learning refers to the development of skills, knowledge, and experience. Through learning, the effectiveness of those experiences can be assessed, and appropriate action can be taken (Cyert and March, 1963; Inkpen, 1995). Learning is defined as *"the ability to process knowledge through which the range of potential behaviors can be increased"* (Huber, 1991: 89) and involves acquisition *and* exploitation of new knowledge by an organization (Kumar and Nti, 1998).

Before elaborating on several organizational learning constructs, we briefly discuss different types of knowledge, which require different learning strategies. Information differs from know-how, the learning of tacit knowledge differs from that of explicit knowledge, internal learning differs from external learning, and explorative learning from exploitative learning.

Information is all about *what* to do while know-how is all about *how* to do it. On the one hand, information - e.g., facts and data can be learned easily once decoded. Know-how, on the other hand, is more difficult to transfer to others.

[40] See: Doz et al. (2001) on "meta-national structure", as discussed in Chapter 2.

Know-how, defined as *accumulated skills*, describes current practices or routines within a firm (Kogut and Zander, 1992: 386). Know-how can be categorized into explicit know-how, which can be codified, and tacit know-how, which is less explicit and more ambiguous, and thus more difficult to codify or transfer to alliance partners (Child and Faulkner, 1998; Kumar and Nti, 1998; Simonin, 1999). The greater the tacitness of knowledge, the lower the accessibility, especially in the case of formal learning strategies (Janowicz-Panjaitan and Noorderhaven, 2008).

Certain learning are aimed at exploration - i.e. experimentation with new alternatives -, while other types of learning are aimed at exploitation - that is refinement and the extension of existing technology aimed at efficiency. Different learning strategies, resources and capabilities are necessary in achieving the various learning goals (March, 1991); exploitation needs routinized learning, while exploration activities require a thinking-out-of the-box learning style, in which breaking-away from existing rules, norms, and routines is encouraged (Nooteboom, 2000).

In addition to different types of knowledge, we discuss general characteristics of learning processes, as listed in box 3.7.

Box 3.7: General characteristics of organizational learning

1. *Cyclical character of learning*
2. *Organizational learning differs from individual learning*
3. *Absorptive capacity*
4. *Differential learning*
5. *Combinative capability*
6. *Cognitive distance*
7. *Paradoxes of information and replication*

Organizational learning is an *iterative, dynamic process*, in which firms learn from their own experiences and from the experiences of others. They connect experiences to each other, draw conclusions from them, and use them in the future.[41] This leads to reevaluating and revising conditions, which in turn leads to re-adjusting and renewing learning processes. Organizational learning therefore, should be viewed as a cyclical process (Child and Faulkner, 1998; Doz and Hamel, 1998; Nooteboom, 2000).

[41] Levitt and March (1988:319) view organizational learning as a history-dependent, routine-based and target-oriented process

Learning processes differ at the *individual, group, organizational and network level* and require different learning strategies (Lynn, 1998; Nooteboom, 1999a; Crossan et al, 2002). Learning starts at the individual level where potentially useful information is sensed and acquired. When knowledge is transformed from an individual to a collective state, it is known as *organizational learning*. In the case of organizational learning, personal and group information and know-how should be embedded in or transferred to the organizational level Frequent interaction within small groups through a unique (codified) language is desirable, involving cognitive and behavioral adaptation with attention to the learning process and outcome (Kogut and Zander, 1992; Inkpen and Crossan, 1995). With organizational learning, new knowledge is utilized and the competences of organizations are improved (Prahalad and Hamel, 1990; Huber, 1991; Inkpen, 1995).

A prerequisite of organizational learning is a firm's ability to value, assimilate, and utilize new external knowledge. This is known as *absorptive capacity* (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998), which depends on the characteristics of external and internal knowledge (Lane et al., 2006). One of the factors that affect a firm's ability to absorb skills from its alliance partners is the similarity of both partners' knowledge bases or *technological capital*, as determined by their experiences in related technological areas. Furthermore, absorptive capacity is determined by the quality of the human assets, and the organization structures and cultures. A firm's ability to absorb capabilities from its alliance partner depends also on the pre-alliance relationship (Cohen and Levinthal, 1990; Mowery et al., 1996; Lane and Lubatkin, 1998; Nooteboom et al., 2007). The greater the absorptive capacity, the more benefit a firm can extract from new knowledge (Kumar and Nti, 1998).

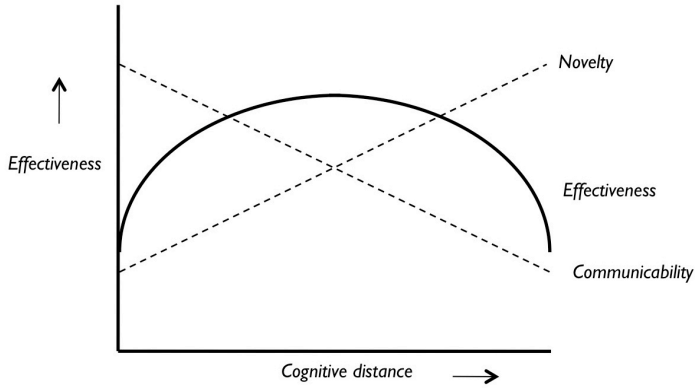
The concept of *differential learning* was introduced (Kumar and Nti, 1998), in order to stress the fact that the alliance partners may differentially acquire knowledge. In an alliance, firms may have unequal capacities to learn from partners, when they have different relative absorptive capacities. This affects the learning balance within the alliance, and consequently the balance of power between the partners (Lane and Lubatkin, 1998).

In addition to absorptive capacity, the *combinative capability* concept is important: *the ability to synthesize and apply current and new acquired knowledge, skills and capabilities* (Kogut and Zander, 1992: 384). Firms have a limited capacity for processing information. With learning however, this capacity may be increased (Huber, 1991). Especially when implementing innovations, new knowledge based on the abilities of alliance partners is required. Firms therefore invest in those assets or the alliances with which they are able to combine their current

capabilities (Kogut and Zander, 1992). Complementary knowledge is a prerequisite when searching for knowledge. Firms will seek knowledge in a complementary area rather than additional knowledge in the same area in which they already have a knowledge base. Alliances play an important role in accessing new information, integrating it in the existing knowledge base and facilitating the use of this new knowledge (Grant and Baden-Fuller, 2004).[42] A large combinative capacity facilitates companies in making better use of external capabilities.

The differences in fields of knowledge, known as *cognitive distance,* are essential, as illustrated in Figure 3.4 (Nooteboom, 1999a; Nooteboom et al., 2007). The more varied these fields are, the more novelty value[43] there is to be gained from the alliance partners but at the same time, the more difficult it will become to transfer fields of knowledge to one another. Cognitive proximity makes understanding easier, but at the same time, implies less novelty value. Learning is most effective at a cognitive distance that is neither too large nor too small. In co-innovation alliances, we expect a hill-shaped correlation between performance and cognitive distance. Optimal *cognitive distance* depends on *absorptive capacity*; with more knowledge, one needs larger cognitive distances to find novelty. The optimal cognitive distance is larger in exploration activities, where more novelty is necessary, than in exploitation activities (Nooteboom et al., 2007).

Figure 3.4: Cognitive distance



Source: Nooteboom (1999a).

In the context of co-innovation, the concept of the *information paradox* is essential (Chesbrough, 2006) - i.e., a provider of information that has to disclose it

[42] In addition, employees are indispensable that can mix and match ideas, people and technologies in a role known as "cross-pollinator" (Kelley, 2005).
[43] Sometimes, the term 'novelty value' may have a negative connotation, referring to a temporary or fashionable newness. We use this term in the positive sense as it is understood in the professional literature.

in order to enable the potential receiver to judge the value of the information. If disclosed however, the receiver may decide not to purchase it and may possibly benefit from the information at no cost. An *information paradox* normally exists during the transfer of explicit knowledge. The *information paradox* can be compared with the *paradox of replication*, which expresses a fundamental dilemma in technology transfer. When knowledge is replicated to external partners, it can be used in order to achieve faster sales growth. At the same time however, it involves the risk of imitation by external partners, which may lead to erosion of the market position of the knowledge provider. Codification of knowledge has the advantage of easier and more cost-efficient (intra- or inter-firm) technology transfer, offering the possibility of achieving scale in knowledge reuse and thus of business growth (Hansen et al., 1999: 108). At the same time, codification involves the risk of imitation. The risk of imitation after technology transfer depends on the skills of the receiver of the technology. New technologies may be transferred to the least capable users, whereas the most capable competitors might imitate a technology, for instance by reverse-engineering[44] a product. This results in a race between innovators and potential imitators, which is considered to be a new form of competition. Firms tend to compete not only with their own knowledge, but also through their ability to imitate the successful product innovations of their competitors (Kogut and Zander, 1992) or benefit more from innovations than alliance partners (Gulati et al., 2000).[45] De Geus (1988: 71) even considers the ability to learn faster than competitors the only sustainable competitive advantage.

The literature describes several facilitating factors for organizational learning, through which capabilities within co-innovation alliances may be developed (Doz, 1996; Simonin, 1997; Gulati, 1998, Anand and Khanna, 2000; Kale et al., 2002), five of these are listed in box 3.8.

Box 3.8: Facilitating factors for learning

1. *Learning intent*
2. *Managerial support*
3. *Relational capital*
4. *Capabilities*
5. *Organization*

[44] That is, analyzing the engineering of a product in detail with the purpose of imitation.
[45] E.g., through the exploitation of knowledge that have been acquired via the alliance in other businesses.

The more receptive people are, the more likely they are to learn (Child and Faulkner, 1998). *Learning intent* is important, for instance for the ability to transfer technology.[46] The amount of acquired knowledge is influenced by the recipient's intent. In addition to this, the intent to acquire knowledge, skills and abilities is just as important as the transparency of the partner's knowledge (Hamel, 1991). The learning intent may also be counter-productive due to the fact that a high learning intent may provoke higher knowledge protection by a supplier of knowledge. Knowledge protection can only be reduced by high level of trust between partners (Hamel, 1991; Child and Faulkner, 1998; Norman, 2004). Learning intent is dependent on strategic intent; for instance, the learning intent in link-alliances differs from that in scale-alliances (Dussauge et al. 2000, see Chapter 2).

Higher levels of *managerial support* provided by the partners to the alliance, may lead to enhanced learning within the alliance. Child and Faulkner (1998) conclude that commitment and direct personal involvement of senior management facilitate learning, however higher levels of technical support provided by the foreign partner do not automatically enhance alliance learning (Child and Faulkner, 1998; Steensma and Lyles, 2000). Management "support" may even become counter-productive if a set of rigid managerial beliefs is imposed on the alliance, which may result in an unwillingness to *un*learn past ineffective practices, consequently the effectiveness of organizational learning might be limited (Inkpen and Crossan, 1995). Nevertheless, management plays a role in managing and solving conflicts or problems in a co-innovation alliance, which when undertaken wisely, may lead to more learning within the alliance (Kale et al., 2000).[47]

A third facilitating factor is *relational capital*. Kale et al. (2000) report that the greater the relational capital between the alliance partners, the greater the degree of learning achieved will be. If there is a lack of trust, emotional barriers impede learning (Child and Faulkner, 1998), however, excessive relational capital may be harmful to productive business-oriented relationships (Gargiulo and Ertug, 2006). We discuss the aspect of relational capital in the next chapter.[48]

Firms develop *learning capabilities* by learning to acquire knowledge by experience. Firms with greater collaborative experience usually achieve higher levels of collaborative know-how and more tangible and intangible benefits (Simonin, 1997; Child and Faulkner, 1998). A higher level of alliance experience facilitates the aggregation of the information at the organizational level

[46] We included this insight in the dependent variable *Technology transfer*.
[47] We included these insights in the dependent variable *Management involvement*.
[48] See: the sections on the performance drivers *trust, management involvement* and *interpersonal relationships*.

(Heimeriks and Duysters, 2002a). Experience in related technological areas is important in determining absorptive capacity: the process of acquiring knowledge is more effective where the alliance partners have a certain amount of complementary knowledge (Inkpen, 2000). Technological learning is based on a combination of internal and external learning: within co-innovation alliances, firms may learn *from* or *with* its partners (Inkpen, 1995; Child and Faulkner, 1998). In the first case, only access to a partner's knowledge and skills is necessary. The second case - learning with others - requires both technological and social capital. For the development of technological capital, strong internal technological capabilities are necessary, which are supported by a small alliance portfolio. Companies that depend on external learning will focus on building up social capital; they acquire new technology mainly through their alliance partners while using a minimum amount of internal technical know-how. These types of internal and external learning reinforce one another.[49]

An appropriate *organization* is essential to both organizational learning and transfer of technology, which necessitates an adequate design at various levels of interface, division of tasks and protection of knowledge between the partners (Hamel, 1991). We include the aspects of organization in our model that we coined *coordination* and *contract need*.

At the same time, several factors might complicate the organizational learning process, as listed in box 3.9.

Box 3.9: Complicating factors for learning

1. *Motivational barriers*
2. *Divergent goals*
3. *Protection of knowledge*
4. *Cultural differences leading to organizational barriers*
5. *Insufficient "unlearning"*

Motivational barriers might impede the transfer of knowledge, such as a lack of commitment, insufficient confidence, inclination to re-invent the wheel, non-compliance, jealousy, or resistance to change known as not-invented-here-mentality (Szulanski, 1996). Motivational barriers also have a negative impact on

[49] We include the aspect of learning capabilities in our model in the sections on the *balanced competences* and *technology transfer*.

the level of trust and the intensity of interpersonal relationships between alliance partners.

Cooperation and competition has an effect on learning within alliances. Partners in the co-innovation alliance may have *divergent goals*, both on the individual and the organizational level.[50] Individuals may derive private benefits - such as incentives from outside parties - which might come into conflict with the alliance goals (Khanna et al., 1998). If the opportunities outside the alliance prove to be more promising, a partner might be inclined to act more opportunistically and not in the best interest of the alliance. Especially a lack of reciprocation of interest between the partners may impede the inclination to transfer technology; a lower level of knowledge transfer is to be expected in unilateral than in bilateral contracts (Mowery et al., 1996). Furthermore, if partners compete, the accessibility of knowledge will be reduced (Inkpen, 2000).

A third complicating factor is the inability to *protect core knowledge* and core proprietary assets, which in turn leads to restrictive technology transfer, resulting in a decrease of trust, an inclination to coordinate and control joint activities tightly, and eventually the dissolution of the co-innovation alliance (Kale et al., 2000).[51]

The learning process may be hampered by *cultural differences.*[52] Different cultures may have different implicit learning strategies. In some cultures, learning is considered to be a linear process – e.g., focusing on analytical learning, based on individual effort. In other societies, learning is considered to be much more sequential, experiential, intuititive and team-oriented. These different learning styles across multiple cultures might lead to misunderstandings, conflicts, and difficulties in cooperating (Prahalad, 1998). Furthermore, different organizational routines, or a culture of protectiveness and reluctance to disclose know-how, might hinder the learning process (Simonin, 1999). Cultural differences may lead to organizational barriers that may form obstacles to knowledge transfer - e.g., the recipient's lack of absorptive capacity, causal ambiguity between knowledge and the desired results, or a disturbed relationship between the source and the recipient of the knowledge.

A lack of ability to *"unlearn" counter-productive practices* might be a complicating factor in learning new practices.[53] By "unlearning", companies are more able to think-out-of-the-box, which is essential to innovation. Therefore – apart

[50] We include the aspect of divergent goals in the strategy control variables on *Strategic, Technological and Cost-saving motives*.
[51] We include the aspect of protection of knowledge in the independent variables: *Contract need, Coordination need, Trust and Technology transfer.*
[52] See: the independent variable *Cultural fit*.
[53] We include the aspect of 'unlearning' the independent variable: *Technology transfer.*

from learning - the unlearning of constraining routines is important to co-innovation alliances (Hamel and Prahalad, 1994), as illustrated in box 3.10.

Box 3.10: Thinking out of the Box

"The difficulty lies not in the new ideas,
but in escaping from the old ones"

Source: John Maynard Keynes (1937: xxiii).

In conclusion, we discuss the nature of co-innovational learning, the aspect of protecting know-how and the balance between technological and social-psychological contracts.

Exploration and exploitation activities require *different learning styles*. For co-innovation, exploration is most important. In exploration, where search for novelty is essential, more emphasis should be placed on cognitive distance than in exploitation (Nooteboom et al., 2007). In exploitation, the activities of cooperation are more similar to one another, which facilitates specialized learning. This may complicate the acquisition of knowledge from *other* businesses, which may result in a possible lack of learning *new* skills or insufficient selection and implementation of non-conforming activities (Vanhaverbeke et al., 2003).

In co-innovation alliances, learning is just as important as the *protection of critical intellectual property*. The managers involved should find an adequate balance between openness to new ideas while protecting vital company interests, thus avoiding the risk of being hollowed-out by alliance partners who might have their own competitive interests in mind (Lei and Slocum, 1992; Prahalad, 1998).

Alliance partners should jointly organize their learning processes, and discuss openly their shared expectations concerning the respective contributions of the partners within the alliance, which includes discussions concerning shared perceptions, uncertainties and risks, as well as levels of commitment to the alliance.

In addition to technological discussions, social-psychological contracts are also essential. When unexpected dilemmas arise during the innovation process - which is usually the case in innovation - misunderstandings and conflicts may hamper the learning processes. Significant imbalances between formal technological and informal social-psychological contracts may lead to underperformance, and possibly to dissolution of the co-innovation alliance (Smith Ring and van de Ven, 1994; Kumar and Nti, 1998).

3.6 SUMMARY AND CONCLUSIONS

In this chapter, we discussed four theoretical perspectives, which form the basis of our model: network theory, contingency theory, organizational learning theory, and a resource-based view. We reviewed their implications on the performance of co-innovation alliances.

Networks and networking play an important role in co-innovation alliances. In network theory, we discussed the effects of the drivers of networking, the size of a network, its diversity, and the effect of the interdependence of partners. In addition to this, we identified as important factors the structure of a network, its context, the intensity of the relationships, the position of a partner within a network, its networking capabilities, and the balance between structural and personal embeddedness. Last, we discussed how networks evolve gradually.

Evaluating the competences of partners vis-à-vis one another, which is the perspective of the resource-based view, is a vital element in assessing the performance of co-innovation alliances. With the resource-based view, we assessed the influence of the competences of a firm and its partners, where the development of competences, experience and specialization are important. Competences may be developed by selection, the training and coaching of personnel, or by cooperating with external partners. Some factors complicate the development and use of competences, such as tacit knowledge, a dynamic environment, or protection of knowledge. Finally, we identified dysfunctional aspects of core competences (core rigidities).

Competences should fit with one another: for alliance performance appraisal, a fit between the alliance partners, or between the alliance and the environment, is essential, which can be analyzed through the lens of contingency theory. In the discussion concerning contingency theory, we described the necessity of multiple fits between alliance partners, together with the effects of market fit, strategy fit, resource fit, organization fit and culture fit on the performance of co-innovation alliances.

The existence of several 'fits' however, is a *conditio sine qua non* but not sufficient. A company can only benefit from its co-innovation alliance if it is able to understand the internal processes of digesting and implementing additional knowledge effectively. In understanding the internal processes of acquiring, processing and using additional knowledge effectively, we elaborated on organizational learning theory. Appropriate learning intent, managerial support, the influence of relational capital, the availability of learning capabilities, and an appropriate organization facilitate organizational learning. We went on to discuss

several barriers in organizational learning, such as lack of motivation, divergent goals, the protection of knowledge, cultural differences, organizational barriers, and an inability to *un*learn inappropriate practices.

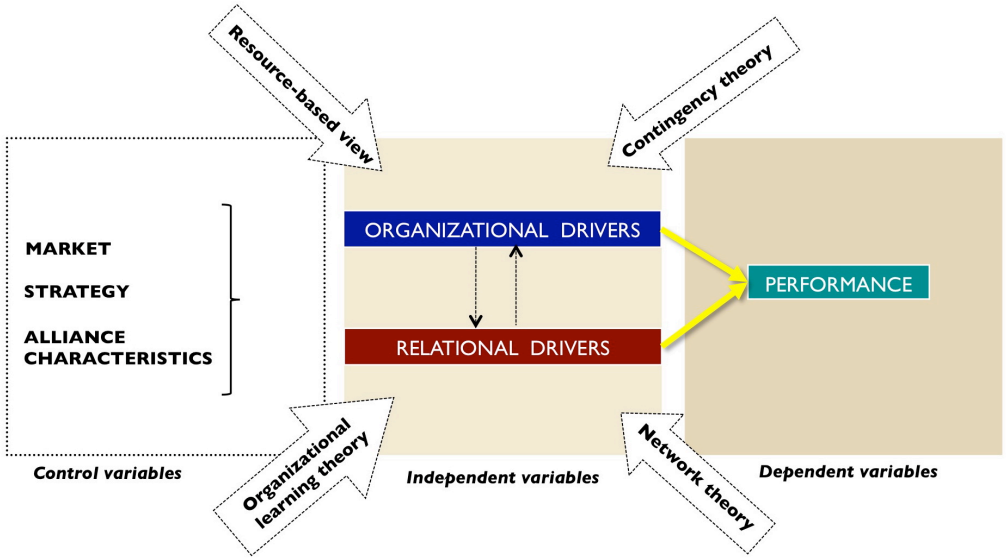
In the next chapter, we use the insight of theoretical perspectives to formulate several hypotheses concerning co-innovation performance.

4 PERFORMANCE DRIVERS

4.1 INTRODUCTION

In this chapter, we build a conceptual framework consisting of dependent variables (performance), independent variables (organizational and relational), as illustrated in Figure 4.1.

Figure 4.1: Variables of the COINN model

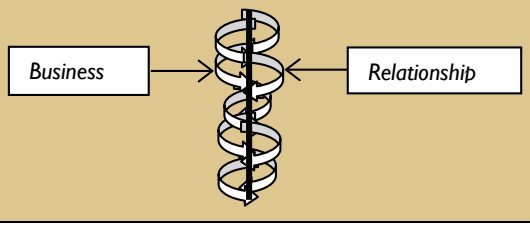


As described earlier, each variable in our COINN model is derived from adjacent research areas, such as that on strategic alliances, joint ventures, inter-firm cooperation, and research into the context of the aforementioned four theoretical domains.

We define performance, elaborate on practicalities regarding measuring performance, and conclude with the description of the performance criteria that we used. We analyze which organizational factors and processes contribute to the performance of co-innovation alliances, and *how* these factors and processes interact with one another in determining alliance performance. Not only do structural factors count, but also the personal relationships among the managers involved. These structural and relational aspects mutually influence one another (Faems et al., 2008) at different aggregation levels: the personal (dyadic), intra-firm, inter-firm, and the network level.

Box 4.1: Business and relationships as a DNA-molecule

"Business and relationship are intimately intertwined with one another like a DNA-molecule; they are difficult to isolate or separate, and most certainly work together to create the entity, bonded together by psychological contracts that exists between the partner organizations".



Source: Spekman and Isabella (2000: 77).

In studies concerning the structural aspects of an alliances' success or failure, collaborative advantages and firm-specific capabilities in the development of alliances are studied, such as in (mis)matches regarding strategy, structure or alliance governance. Other aspects are (in)proper execution or (in)ability to deliver the expected competences (Duysters et al., 1999; Dyer and Nobeoka, 2000; Ireland et al., 2002; Kale et al., 2002).

Relational factors contribute considerably to the performance and success of co-innovation alliances - for instance, when alliances have to cope with unforeseen circumstances (Kauser and Shaw, 2004). At the relational level, patterns of behavior are described. Main sources of success or failure include the level of trust and loyalty, sufficient management commitment and previous experiences. Other sources include the level of coordination and integration, clear rules of engagement, accountability, and relational capital (Dyer and Singh, 1998; Khanna et al., 1998; Madhok and Talman, 1998; Yan and Zeng, 1999; Kale et al., 2000).

4.2 DEFINING AND MEASURING PERFORMANCE

Measuring the performance of co-innovation alliances is complex and few companies succeed in assessing the performance of their alliances systematically. Dyer et al. (2001) report that over fifty-one percent of alliances do not implement performance metrics at all. In addition, few firms are confident that their measurements of innovation performance are valid. Improvement of

measurement and the management of innovation activities are major concerns of innovative companies (Boston Consulting Group, 2006a,b).

For alliance stability and success, the perceived output of the alliance in both the short and long-term should be larger than the joint input of the individual partners (Bamford and Ernst, 2002; Bamford et al., 2003). The output of the co-innovation alliance might be a direct and tangible outcome, such as a new innovative product or service, but can also be an indirect outcome, such as the development of a new technology, new know-how or market access. The input of the partners might consist of capital, assets, raw material, manpower, specialized staff, know-how, business systems, technology, market intelligence, brands, customers, and more.

For the adequate performance assessment of innovation activities, the selection of an appropriate set of metrics is not sufficient. An adequate business model is necessary, involving a description of *how* the company can be innovative, *which* innovation processes are needed, and *how* it will generate value from innovation because a measurement system is considered to be only as good as the underlying innovation business model (Kerssens-van Drongelen and Bilderbeek, 1999; Chesbrough, 2003b; Davila et al., 2006). Furthermore, awareness of performance measures should lead to the corrective actions in the case of underperformance or proactive actions in order to improve performance (Stober and Grant, 2006).

The success of co-innovation is difficult to predict and assessment of performance is complex, due to technological complexity, uncertainty, dynamism, and the nature of the collaboration, i.e. with *external* partners. Chesbrough (2004) illustrates this by using the metaphor of playing poker as opposed to chess. A chess player plays on a fully defined battlefield of sixty-four squares, with exactly defined tools against one combatant. In a fully defined game like chess, the player with superior skills to predict and adapt will win. In co-innovation however, many circumstances are uncertain and the poker metaphor is more applicable: based on the information available at that time, a player decides each game whether to continue playing (by taking new chances) or quitting. In managing co-innovation alliances, therefore the participants in an alliance must be able and willing to adapt resources with a high degree of flexibility.

We consider the performance concept to be interest driven, subjective, and multi-dimensional.[1] It is assessed relative to the various objectives driving an

[1] Gulati (1998) and Kale et al. (2002) researched different perspectives of performance. The interest-driven side of performance was researched by Hamel et al. (1989), Hill and Hellriegel (1994) and De Man and Duysters (2002). Ariño (2003) researched content and discriminant validity of several measures of performance, such as strategic performance.

alliance that may conflict with one another or be changed during the cooperation. As discussed in Figure 2.5, we concentrate on three aspects of performance: the commercial, technological and financial aspect (see Table 4.1).

In a co-innovation alliance, the partners cooperate in order to develop new products *("growing the pie")* and compete at the same time as well in the allocation of the benefits, such as profit and ownership *("sharing the pie")*. This balance between intra-alliance competition and collaboration needs to be managed constantly (Brandenburger and Nalebuff, 1996). We therefore measure performance in absolute terms, such as the pay back period or financial growth, as well as in relative terms – e.g., the ownership of intellectual property rights.

Table 4.1: Aspects of performance

Aspect	Performance criteria	References
Commercial performance	1. Marketing benefits, such as the rights of partners to market or distribute the alliance output, 2. Ownership of intellectual property rights, 3. Reduction of corporate risk or uncertainty, 4. Contribution to the competitive position, 5. Integration of the co-innovation project into the existing corporate business, 6. Growth opportunities for market share.	*Calogirou et al. (2003); Goerzen (2005); Andrew and Sirkin (2006);*
Technological performance	1. Possibilities to acquire knowledge, 2. Access to complementary resources, 3. Exploitation of research synergies, 4. Achievement of learning objectives, 5. Improvement of the innovative, corporate portfolio, 6. Learning balance.[2]	*Andrew and Sirkin (2006); Sydow and Windeler (1998); Calogirou et al. (2003); Boone et al. (2005); Goerzen (2005); Pansiri (2005); Andrew and Sirkin (2006).*
Financial performance	1. Cash spending, 2. Revenue growth, 3. The period leading up to a positive cumulate cash flow or break-even outcome, 4. Reducing costs through the partnership, 5. Achievement of financial and strategic objectives.	*Kogut (1989); Hagendoorn and Schakenraad, (1994); Sydow and Windeler (1998); Baum et al. (2000); Goerzen (2005); Boston Consulting Group (2006); Tjemkes (2008).*

Finally, the subjectivity of performance was researched by Geringer and Hebert (1991), Boone et al. (2005), and Pansiri (2005).

[2] That is, partners learn equally from one another.

In Chapter 5, we will evaluate the performance criteria and construct scales for our dependent variables concerning performance.

4.3 ORGANIZATIONAL DRIVERS

4.3.1 CONTRACT NEED[3]

A sufficient level of flexibility is an essential part of creative and innovative processes. At the same time, managers have to implement effective control mechanisms in order to be able to monitor progress, and adjust if necessary. However too much or the wrong type of control may constrain the team's creativity, hamper progress, and lead to under-performance (Bonner et al., 2002). In this section, we discuss the necessity and consequences of formal controls in co-innovation alliances.

To a certain extent, contractual safeguards are necessary, especially when specific assets are required for a limited period (Reuer and Ariño, 2007). Contracts are used to decrease opportunistic behavior by the contract partners, which affect the performance of alliances (Mohr and Spekman, 1994, Cannon et al., 2000; Kauser and Shaw, 2004; Dekker, 2004).

In certain cases, formal controls may become counter-productive. Putting much emphasis on legal safeguards rather than on cooperation is considered a major pitfall in alliances (Jagersma, 2005). Such an attitude can result in a legalistic approach, which might have a negative impact on alliance performance. When a contract becomes excessively detailed, it will become inflexible and complicates monitoring compliance (Luo, 2002; Poppo and Zenger, 2002). This is especially a risk with co-innovation.

Negotiating contractual safeguards should be carried out at the appropriate time, after the essence of the innovation alliance has been agreed upon. In other words: negotiate business logic before control issues: *"first identify the pie (opportunities and synergies) - before allocating the slices, such as profit and ownership issues"* (Jagersma, 2005: 49).

The choice of the most effective control mechanism in achieving innovation outcomes is dependent on the desired level of innovativeness: a high degree of formal controls has a negative impact on project performance in highly innovative projects (Bonner et al., 2002).

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[3] This variable is based on organization fit (contingency theory) and the insights concerning organizational context and barriers (organizational learning theory).

The effectiveness of managerial control mechanisms depends on the type of knowledge a project depends upon: sometimes, formal control mechanisms are preferable; and in other cases, informal controls are more suitable. In the management of explicit knowledge, formal control mechanisms, such as outcome control and process control,[4] do have a positive effect on project timeliness. At the same time, in the case of managing tacit knowledge, formal control mechanisms have a positive effect on creativity. On the other hand, informal control mechanisms – for instance, clan control – will have a more positive effect on product quality when knowledge is tacit rather than when knowledge is explicit (Rijnsdijk et al., 2009). This is illustrated in Table 4.2.

Table 4.2: Effectiveness of (in)formal control mechanisms

	Exploitation activities (such as efficiency, product quality, and timeliness)	*Exploration activities (such as creativity, and innovation)*
Tacit knowledge	Informal control mechanisms (clan control)	Formal control mechanisms (outcome control, process control)
Explicit knowledge	Formal control mechanisms (outcome control, process control)	

Adapted from: Rijnsdijk et al. (2009).

Co-innovation usually involves more tacit than explicit knowledge; in this case, therefore, informal control is preferable for product quality.

The adequacy of formal controls is dependent on the aim of cooperation. In cases where learning is important, formal contracts tend to be less important (Hamel et al., 1989). Moreover, companies that are confident of their ability to learn may consider formal contracts less important, and might even prefer more ambiguous loose contracts with more freedom to acquire skills and technologies (Hamel et al., 1989).

[4] In outcome control, output is specified and evaluated. In process control, behavior is specified and evaluated. Informal or clan control is based on socialization of team members

Box 4.2: Contracts and relationships

"Formal contracts do not make successful relationships; people do"

Source: Sonnenberg (1992: 49).

The decision to rely on formal contracts is influenced by culture differences. For example, American managers normally prefer formal contracts in order to avoid conflicts and uncertainties, whereas Japanese managers prefer mutual discussion and mediation to formal contracts (Park and Ungson, 2001).[5]

Establishing a balance between formal and informal contracts is essential. On the one hand, excessive reliance on formal, legal procedures obstructs the possibility of building up the informal, interpersonal relationships, which are necessary for implementing activities in the co-innovation alliance successfully.[6] On the other hand, over-investing in the relationship can also lead to inefficiencies or business risks (Ring and Van de Ven, 1994).

Detailed formal contracts reduce the flexibility to adapt to unforeseen circumstances, which will definitely arise during the innovation process. We expect that too much emphasis on contractual safeguards in advance, (a legalistic approach) leads to less flexibility. This would hamper the co-innovation process, because freedom to experiment is necessary. In the absence of flexibility, alliances are restricted to executing pre-defined obligations between parties, lacking the means to adapt creatively or innovatively to changing circumstances, which may lead to market[7], strategic, and organizational misfits, as described in the section on contingency theory. The more contractual an alliance is, the more inflexible it will become, which impedes the innovation process, due to organizational barriers, which complicate organizational learning and creativity (Spekman et al., 2000; Strebel, 2003). Based on the above, we suggest

Hypothesis 1: *CONTRACT NEED*

An emphasis on agreeing upon many details and a formal contract in advance is negatively associated with the performance of a co-innovation alliance.

[5] Hamel et al. (1989: 139) illustrate this by stating: the challenge for Western companies is "not to write tighter legal agreements but to become better learners".

[6] The relationship between contractual safeguards and alliance performance depends on both the level and type of trust (Lui and Ngo, 2004). We discuss the independent variables "trust" and "personal relationships" in more detail in Section 4.4.

[7] Synonymous with environmental fit.

4.3.2 EMBEDDEDNESS[8]

Embeddedness, as defined in Section 3.2 on network theory, influences alliance formation and management (Emden et al, 2005). Embeddedness of a firm and its partners is dependent on previous experience with external cooperation, the position within networks, the size and interdependency between partners within the network.

The relationship between *alliance experience* and performance is complex, and entails general alliance and partner-specific experience, i.e. leaning effects across multiple and a single partnership, respectively. Hoang and Rothaermel (2005) conclude that general alliance experience has a positive, although diminishing, effect on alliance success, whereas partner-specific experience *may* decrease alliance performance.

Experience in external cooperation is a positive factor for alliance performance; when one of the partners is inexperienced in alliance management, the chance of success might be reduced (Park and Russo, 1996; Draulans et al., 2003). Through experience, partners can develop their skills in managing alliances (AWT, 2006).

Furthermore, when partners have joint experiences, they develop higher levels of collaborative know-how (Simonin, 1997; Beckman and Haunschild, 2002; Emden et al., 2005). Joint experiences may be considered as a starting-point for further cooperation on innovation (Lampe and Spekman, 1998; Child and Yan, 2003) where they learn to operate in new areas and learn how to cooperate (Barkema et al., 1997).

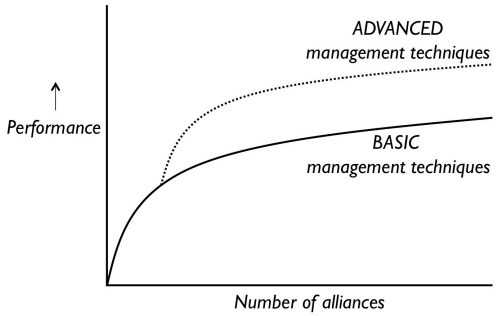
On the one hand, through accumulation of know-how, a higher success rate can be expected, especially in innovation alliances (Anand and Khanna, 2000; Draulans et al., 2003). This learning effect from previous alliances is most beneficial when alliance activities are complex and uncertain (Sampson, 2005) or when companies are inexperienced.[9] The cumulative benefits of alliance experience tend to decrease after a certain level. In this case, a company may exceed its capacity in handling alliances, or cooperation experiences may start to become out-dated. It has been observed that with advanced management

[8] This variable is grounded on the diversity, structure and size of a network (network theory), external cooperation (both in network theory and organizational learning theory), and experience and specialization (resource-based view).

[9] This learning effect cannot be distinguished however, in alliances with weak ties (such as licensing). In marketing alliances, the learning effect might even be negative (Anand and Khanna, 2000). Furthermore, the evaluation of inexperienced companies differs from experienced companies. Inexperienced companies benefit mostly from the evaluation of an individual alliance, while experienced companies mostly from comparing various alliances with one another.

techniques, the success rate can be increased, albeit with decreasing cumulative effects (Draulans et al., 2003; Sampson, 2005). This is illustrated in Figure 4.2.

Figure 4.2: Decreasing learning effects of managing alliances



Source: Draulans et al. (2003).

On the other hand, from a network theory perspective, multiple cooperation with the same partners may lack sufficient variation or may generate 'non-redundant' knowledge, which might be an essential disadvantage in the innovation in an environment of high technological uncertainty (Burt, 1992; Goerzen, 2007).

The *position in networks* determines the embeddedness of a firm and its partners. If a network partner plays a central role in a network, it will usually be trusted more, might have more power, and has an innovative reputation, resulting in more exchange of resources between partners. Furthermore, a highly central firm is likely to be connected to many more knowledge sources than a less central firm, which may be beneficial to the innovation process (Tsai and Ghoshal, 1998). Although network-centrality has positive elements, it entails negative as well. If an industry is considered to be highly dynamic, industry structures can be changed drastically. For instance, in the case of radical innovation, a shift in technological paradigms can make previously required skills and knowledge bases obsolete, or at least less important, and might deteriorate the position of firms with a central position in networks. Therefore, assessing such industry trends in relation to network centrality is relevant for selecting potential alliance partners (Madhavan et al., 1998).

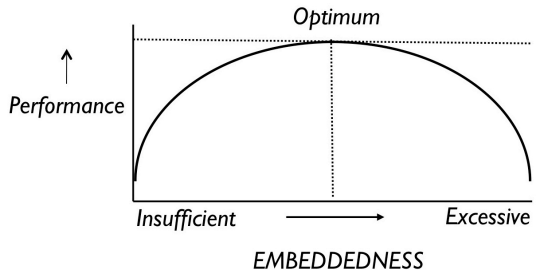
The *size of networks* is important for alliance performance, because with more external relationships, the technical, commercial and social capital of a firm will increase (Walker et al., 1997). Especially social capital is relevant, because firms with higher social capital are likely to have more relationships with new partners, which is considered to facilitate cooperation (Ahuja, 2000b).

Diversity of partners within a network of linkages is essential because having several different experiences prior to the alliance makes information exchange between partners more unique and useful (Beckman and Haunschild, 2002). The same applies to more *interdependency* between partners. Multiple relationships between partners affect decision quality positively (Beckman and Haunschild, 2002). In addition, an alliance, whose partners are tied with multiple linkages simultaneously, is less likely to fail (Kogut, 1989).

The aspects of embeddedness interact with one another and reinforce each other; the greater the number of innovation alliances a firm has, the more experience of managing them is available. This makes a firm more attractive to potential partners enabling them to possess a more central role within its networks. This network-centrality may facilitate further growth and innovation (Powell et al., 1996).

On the other hand, it is also important to consider the effects of too much *embeddedness*. Too much *embeddedness* or over-embeddedness has negative effects: it can lead to too much dependency on the networks, less flexibility and less internal learning (Gargiulo and Ertug, 2006). High *embeddedness* with existing partners might be less adequate in environments of greater technological uncertainty (Goerzen, 2007). This is illustrated in Figure 4.3.

Figure 4.3: Performance and embeddedness



We define our variable our variable '*embeddedness*' as the sum of experience with network relations, the number of partnerships and the centrality of network roles of the firm and its partner. Consistent with previous research we conclude with

Hypothesis 2: EMBEDDEDNESS

The relationship between embeddedness and performance of a co-innovation alliance is hill-shaped.

4.3.3 BALANCED COMPETENCES[10]

A situation, in which the contribution of partners is balanced, depends on a resource fit between them (including the complementary or interdependency of their resources), and their organizational learning capabilities. The relative uniqueness of partner contributions is not static; hence the balance of power is dynamic.

First, we discuss the *resource fit* between partners concerning co-innovation performance. On the one hand, when exploiting existing capabilities, firms usually prefer to develop their innovations alone – e.g., when improving existing production techniques or engaging in incremental innovation. On the other hand, they tend to ally when a firm needs to *expand* its capabilities in order to compete more successfully or to explore new opportunities (Gomes-Casseres, 1989; Lei and Slocum, 1991, 1992). By combining complementary (technological) capabilities of alliance partners, companies can boost their innovative productivity (Afuah, 2000; Stuart, 2000). In order to achieve a resource fit, a degree of shared knowledge is essential, which is in line with the cognitive distance theory; a higher level of collaborative know-how increases of both tangible and intangible benefits (Mowery et al., 1996; Chan et al., 1997; Lane and Lubatkin, 1998; Callahan and MacKenzie, 1999; De Man and Duysters, 2002). In order to achieve a resource fit, the contributions should be complementary, compatible and interdependent. Complementarily is important, because firms tend to seek the transfer of knowledge that complements their existing knowledge base. In order to be able to make use of the skills of the alliance partners, they should be compatible (Makhija and Ganesh, 1997; Shenkar and Li, 1999).

Furthermore, interdependence in terms of investment and resources - or even *mutual* interdependency (reciprocity) - enhances the stability of alliances (Porter and Fuller, 1986; Kogut, 1989; Gulati, 1999). Through reciprocity, partners are able to potentially reward or penalize one another's behavior if and when appropriate (Kogut, 1989; Chung et al., 2000). Interdependency of resources is related to the relative bargaining power of the partners towards one another. If a resource is unique and essential to the innovation process, a partner has a greater bargaining power (Kauser and Shaw, 2004). A balance of power and control between partners enhances alliance stability and thus indirectly, performance (Muthusamy and White, 2006). Such a balance of power may shift

[10] We used for this variable insights as to resource fit (contingency theory), interdependency of partners (network theory), and complementary competences (resource-based view and organizational learning).

during the alliance, leading to a possible deterioration of the stability and underperformance of the alliance.

The *organizational learning capabilities* within the alliance influence performance. In co-innovation alliances, firms seek to benefit from the resources of their partners, and increase their own capabilities. This may result in a situation in which a partner is no longer needed, because the benefits of cooperating do not any longer outweigh the costs of the partnership (Gomes-Casseres, 1987), which will change the bargaining power balance between the partners, and may lead to alliance instability (Harrigan and Newman, 1990; Yan and Gray, 1994). A co-innovation alliance can be considered as a race to learn: companies that are most effective in learning from the alliance enhance their competitive position more (Parkhe, 1991). A higher learning-efficiency by one partner may lead to decreased dependency on the other partner in performing alliance tasks, which may improve the bargaining power of one partner (Yan, 1998; Park and Ungson, 2001; Duysters and Heimeriks, 2002b).

The relative importance of the partners' contributions can shift in due course, which, in turn, also affects the relative bargaining power of the alliance partners. For a durable balance of power, the contributions of partners should remain unique, implying that a competence cannot easily be traded, or substituted, developed independently, or replicated within any reasonable time frame. If the partner's contributions are unique, not traded or developed alone, the partner cannot easily be substituted for alternative partners and has a more durable bargaining power in the alliance (Doz and Hamel, 1998). A balance of power also affects decision-making or conflict-resolution within the alliance. A partner with relatively more power is able to force its preferred alternative solution when conflicts arise, and is less likely to propose intermediate solutions ('give and take'). In addition, greater bargaining power gives a partner the opportunity to impose more control on the alliance (Inkpen and Currall, 2004). In the short-term, the benefit from a dominant position may facilitate decision-making and efficiency within the alliance (Park and Ungson, 1997; Garcia-Canal et al., 2003). In the longer term however, such asymmetry in the power balance might destabilize the alliance and decrease its efficacy (Park and Ungson, 2001). An unequal balance of power creates uneven dependency and dissatisfaction in the partnership, therefore willingness to abstain from a high level of management control in order to enhance the level of cooperation might be beneficial in the longer term however, a high degree of foresight, mutual tolerance and trust is necessary (Inkpen, 1995; Steensma and Lyles, 2000).

We define our variable '*balanced competences*' as a situation in which the competences of the co-innovation alliance partners are both unique and durable. Based on the above-mentioned observations, we state

Hypothesis 3: *BALANCED COMPETENCES*

Balanced competences are positively associated with performance of a co-innovation alliance.

4.3.4 COORDINATION NEED[11]

Several factors affect governance structures and the need for coordination between the alliance partners: control mechanisms, organizational structures and performance influence one another simultaneously (Geringer and Hebert, 1989; Yan and Zeng, 1999; Goerzen, 2005). Coordination influences alliances performance and satisfaction of international strategic alliances positively (Kauser and Shaw, 2004).

Innovation is an uncertain process (Chesbrough, 2003b). Co-innovation alliances face added complexity when involved in cooperation with external partners as these partners have their own agendas, their own portfolio of strategies, competences and specific technological complexities. Complexity is one of the primary sources of underperformance in alliances (Park and Ungson, 2001). We will discuss the impact the sources of complexity have on control mechanisms and organizational structures below.

First, the *nature of the innovation process* adds complexity because uncertainty is inherent to innovation, which results in a difficulty-to-control innovation process and the impossibility to foresee all aspects a priori. Innovation is a creative and opportunistic process, which needs space for unexpected occurrences (Drucker, 1985) or serendipity. Therefore, innovation processes can only be organized to a limited extent (Hamel, 1998; Moore, 2005). Capturing serendipity requires flexibility and adaptability (Estrin, 2009). Innovation involves a tension between a certain space for creativity and flexibility, on the one hand, and timeliness, product quality, efficiency and effectiveness, on the other (Leenders et al., 2007, Perez-Freije and Enkel, 2007). Innovation man-

[11] This variable is based on insights regarding the aim of cooperating (network theory), complementary competences (resource-based view), organizational and resource fit (contingency theory), the organizational context and barriers, and the protection of knowledge (organizational learning theory).

agement requires a balance between those forces. Too much freedom, such as a change in specification during the entire innovation process, will cause inefficiencies, but too much rigidity can constrain innovators (Estrin, 2009), as is illustrated by the quotation of a general manager of the innovative US company 3M in box 4.3.

Box 4.3: People and sheep

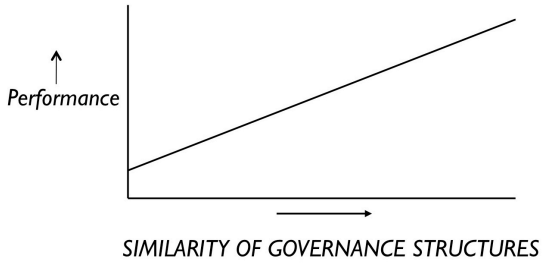
"If you put fences around people, you end up with sheep"

Source: Eberl and Puma (2007: 14).

Second, the *organization and management of an alliance* increases complexity, as the process of governance has a direct impact on performance (Madhok and Tallman, 1998). This involves not only the initial governance structure of the alliance, but also the way it is managed, especially when unforeseen circumstances occur - which are inherent to innovation - require a change of governance structures. New situations will require new balances. Furthermore, the likelihood of change in the governance structure is influenced by - e.g., previous experiences - either with one another or in similar product areas - or by the importance of the alliance to the partners (Reuer et al., 2002). Therefore, in co-innovation alliances, several balances have to be found and managed simultaneously.

This implies a flexible structure of relationships between the headquarters of the partners and the alliance organization, which in turn requires a balance between a need for speed (fast product development, and timely knowledge transfer across markets and businesses) and a need for thoroughness (due to technological issues). Alliance management requires a balance between those forces which involve not only the question of *how* to optimize the governance structure, but also how to retain the capacity for flexible and quick response (Ghoshal and Gratton, 2002). This balance is not only related to the degree of control exercised, but also to the *way* in which the control is carried out (Bamford et al., 2003; Kauser and Shaw, 2004). The balance involves both formal and informal relationships, and affects technological issues, organizational values, behaviors, as well as an appropriate business model (Hamel and Välikangas, 2003). If partners have similar governance structures, these complexities can be tackled more easily. We expect that more similarity leads to more stability in the co-innovation alliance, and consequently better performance, as illustrated in Figure 4.4.

Figure 4.4: Performance and governance structure



We examine the impact of experience, organization fit and competences on the coordination need of partners.

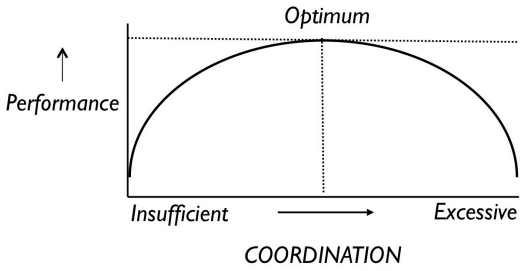
If partners have *experience w*ith one another, this influences the coordination need. A successful pre-alliance relationship between the partners reduces the importance of a formal control structure due to increased levels of trust (Yan, 1998; Park and Ungson, 2001; Duysters and Heimeriks, 2002b). The governance structure and the level of trust between the alliance partners influence one another. If partners trust one another, they depend more on social and less on formal controls. If formal controls are used heavily, there is less development of trust (Inkpen and Currall, 2004).

An *organization fi*t influences a coordination need. A clearly communicated fit of operational policies of the partners - as in management control and production procedures - contributes to alliance success (Duysters and Heimeriks, 2002a). If such a fit is disturbed, for example through an imbalance in the management control vis-à-vis the decision structure, partners may feel an increased need for coordination (Steensma and Lyles, 2000).

Competences and inter-partner learning influence the levels of desired coordination between the partners. One of these competences is the ability of partners to deal with differentiated and flexible structures. Not all partners are able or willing to handle such a differentiated fit, which is necessary for flexibility and innovation (Brown et al., 2002). Inter-partner learning affects the governance structure. A larger technological distance between the partners influences the control need of the partners. On the one hand, partners facing a larger technological distance tend to seek more coordination of activities in order to be able to implement the other's technology. On the other hand, learning or R&D-related motives of partners lead to a preference for less hierarchical governance modes (Makhija and Ganesh, 1997; Inkpen and Currall, 2004; Van de Vrande et al., 2006). Furthermore, if companies are confident of their ability to learn, they may even prefer some ambiguity in the governance structure of their co-innovation alliances (Hamel et al., 1989).

In conclusion, we state that a low level of desired coordination leads to insufficient use of complementary resources, and a high level of coordination will impede the necessary flexibility, creativity and innovation (see Figure 4.5).

Figure 4.5: Performance and *coordination*



We define our variable '*governance fit*' as the perceived similarity of governance structures of the alliance partners and our variable '*coordination need*' as a high level of desired coordination for the co-innovation project, which leads to

Hypothesis 4a: GOVERNANCE FIT

Similarity of governance structures of the alliance partners is positively associated with the performance of a co-innovation alliance.

Hypothesis 4b: COORDINATION NEED

The relationship between coordination need of the alliance partners and performance of a co-innovation alliance is hill-shaped.

4.4 RELATIONSHIP DRIVERS

4.4.1 TRUST[12]

Trust, alliance success, and performance influence one another. Trust can considered to be a key predictor of partnership success and performance, and lack of trust as one of the main reasons for failure (Cullen et al., 2000; Kauser and Shaw, 2004). Trust between the alliance partners has to grow gradually by having positive joint experiences, and can be destroyed just as easily. The development of trust can also be linked to an individual's positive or negative experience with others (Jennings et al., 2000).

Box: 4.4: The importance of trust

"A partnership works on the basis of trust and commitment or not at all"

Source: Park and Ungson, (2001: 51).

Cooperation within alliances requires willingness to accept dependence, which in turn requires the assurance or expectation that the other parties will meet the agreement. These expectations might be based on objective logic (facts) or based on subjective feelings, or beliefs concerning how an alliance partner will behave in a relationship.

There is an emotional and a rational component attached to trust (Cullen et al., 2000; Nooteboom, 1996, 2000). The subjective or emotional element of trust - known as benevolent, intentional or goodwill trust - implies a partner's intention to perform according to agreement (Friedman, 1991). Goodwill trust is linked to relational risk; if intentions fail, one may improve incentives or issue threats.

The subjective element of trust is the most complicated, because if problems occur due to lack of intention, several excuses are possible, such as unfavorable conditions or capability shortcomings (Nooteboom, 2000). The rational component is known as competence trust or credibility trust, implying the confidence that a partner has the ability to deliver its obligations according to agreement. Competence trust refers to the expectation that partners have the ability to fulfill their roles. This is related to performance risk and can be relatively easily evaluated - e.g., by assessing a partner's resource allocation.

[12] This variable is based on insights concerning personal and structural embeddedness (network theory), cultural fit (contingency theory), protection of knowledge (resource-based view and organizational learning theory), relational capital, and organizational barriers (organizational learning theory).

When a partner lacks this ability, one may give support in order to improve it. The two aspects of trust, goodwill trust and competence trust, are closely related to the calculation of different types of perceived risk in an alliance (Das and Teng, 1998, 2004; Lui and Ngo, 2004).

Trust relates to the confidence or predictability of the perceived consistency in one's behavior (Six, 2004). Trust is dynamic, interactive and complex; dynamic, because it can be built but just as easily destroyed; interactive, because it is the result of an interactive process between two or more individuals experiencing each others' trustworthiness. Trust is also complex, because it can be asymmetric (A trusts B, but not vice versa), there is no absolute certainty that trust will be honored, and it is practically impossible to prove, unless there is clear evidence of untrustworthy behavior. Furthermore, trust can be studied at interpersonal, intergroup and inter-firm level, which in turn are linked to one another (Curral and Inkpen, 2002; Faems et al., 2008).

We elaborate upon the processes leading to the development of trust, as listed in box 4.5.

Box 4.5: The positive effects of trust

1. *Less uncertainty*
2. *Lower costs (transaction, coordination or governance)*
3. *Less bureaucratic complexity and more flexibility*
4. *More profitable*
5. *Better conflict resolution*
6. *More openness and consequently a better acquisition of knowledge*
7. *More perseverance and commitment*

Trust can lead to *less uncertainty*, which is extremely important in an environment of high ambiguity and complexity. In these cases, trust can provide a sense of security in order to cope with the accompanying risks (Das and Teng, 2004; Six, 2004; Gargiulo and Ertug, 2006); trust reduces relational risks of cooperation (Nooteboom et al., 1997).

Trust reduces opportunism in alliances, which has the effect of lowering the following *costs*: transaction (Nooteboom, 1999b; Klein Woolthuis et al., 2005), coordination (Lorenzoni and Lipparini, 1999), governance (Ring and Van de Ven, 1992), and/or information-processing cost (Gargiulo and Ertug, 2006). In order to react successfully to major unforeseen circumstances, which might

disrupt the alliance, trust and goodwill are indispensible (Ariño and de la Torre, 1998), due to the fact that detailed contracts are no longer necessary. Mutual trust strongly reduces the necessity for bureaucratic complexity (Park and Ungson, 2001; Six, 2004).

The ability to change is enhanced by trust (Six, 2004) and therefore positively related to the strategic *flexibility* of an alliance (Young-Ybarra and Wiersema, 1999).

Trust is therefore the least expensive mode of governance (Jennings et al., 2000) and relates positively to revenue growth, *profitability* and the market value of a strategic alliance (Jennings et al., 2000).

Trust improves social relationships that *facilitate efficiency and problem solving* and helps to overcome conflicting situations and unexpected difficulties (Park and Ungson, 2001; Six, 2004). Investment in a trustworthy relationship is, on the one hand, especially important in long-term oriented alliances. Short-term alliances, on the other hand, may rely more on exploiting mutual benefits (Cullen et al., 2000).

When alliance partners trust each other, *more openness in information sharing and knowledge accessibility* can be expected (Inkpen, 2000), which is vital in co-development and co-innovation. Trust assists learning, creativity and innovation (Six, 2004); trust leads to a better acquisition of knowledge, due to the fact that the inclination to share new knowledge further reduces the chance of self-centered opportunism, which in turn will lead to the sustainability of the alliance (Ring and van de Ven, 1992; Park and Russo, 1996).

Furthermore, trust leads to *more perseverance and commitment* (Gargiulo and Ertug, 2006), which plays a significant role in overcoming alliance problems, which – if not solved - may lead to termination (Kauser and Shaw, 2004).

We summarize some important items that facilitate building trust within co-innovation alliances in box 4.6.

Box 4.6: Building trust

1. *Positive experience*
2. *Personal embeddedness and familiarity*
3. *Openness, honesty and integrity*
4. *Sharing of benefits and risks*
5. *Commitment and patience*

Through *positive experience*, the inclination of alliance partners to behave opportunistically will diminish, resulting in more predictable behavior, which in

turn leads to trust in one another, and increased embeddedness (Uzzi, 1997). Trust, therefore is a result and origin of success in an alliance (Ring and Van de Ven, 1992; Mody, 1993; Gulati, 1995a; Inkpen, 2000; Jennings et al., 2000; Inkpen and Currall, 2004). Through positive experience during an alliance, partners become more familiar with one another, which leads to a more open style of problem-solving, with less legalistic conflict resolution, and a greater willingness to adopt the partners desired course of action (Lin and Germain, 1998). The extent to which alliance partners have a history of positive experience will significantly influence the degree of trust (Park and Ungson, 1997).

Personal embeddedness will build trust. Personal embeddedness is a necessary condition for trust (Ring and Van de Ven, 1992; Handy 1995), because trust is based on individuals or small groups: one cannot trust another company - only people can trust each other (Jennings et al., 2000). Deliberately increasing personal capital will facilitate the trust-building process.

This implies a certain degree of *openness* between alliance partners, where individuals express ideas openly and freely to one another. Through open and direct communication partners understand and – to a certain extent - predict one another's behavior by using implicit and explicit rules together with the routinized exchange of information (Jennings et al., 2000). The level and quality of communication between the partners improves if partners trust one another (Young-Ybarra and Wiersema, 1999). This facilitates organizational learning by reducing motivational or organizational barriers. Furthermore, partners tend to become less restrictive in protecting propriety know-how when they trust their alliance partners.

Through a *shared vision or values*, partners can build trust between one another. Clearly defined collaborative objectives will stimulate the initial development of trust between partners (Inkpen and Currall, 2004). In this case, partners develop a mutual understanding concerning the tasks to be performed by each alliance partner and the accompanying behavior (Tsai and Ghoshal, 1998; Young-Ybarra and Wiersema, 1999; Cullen et al., 2000). Furthermore, they perceive the benefits and risks of the alliances to be fair and mutually beneficial (Jennings et al., 2000).

In order to develop trust, *patience and the commitment* is essential. Trust cannot be built overnight and seldom comes easily (Jennings et al., 2000; Park and Ungson, 2001). Because it takes time to realize a high level of trust among partners, firms tend to duplicate their existing ties with former partners instead of initializing new ones (Duysters and Heimeriks, 2002a).

Trust is indispensible, but not the only condition for a co-innovation alliance. An appropriate mix between trust and (in)formal controls should be estab-

lished (Poppo and Zenger, 2002). In the literature, it has been argued whether control and trust substitute or complement one another (Dekker, 2004; De Man, 2006).[13] Does more trust lead automatically to less control? Extensive use of formal control suggests a lack of belief in one's goodwill or competence, and therefore results in a damaging effect on relational trust (Das and Teng, 1998).

If trust and control are complementary to one another, an increase in the level of trust results in a lower level of control (Das and Teng, 1998). To a certain extent, the use of formal controls may be complementary to developing trust. Trusting alliance partners will develop a greater awareness, or willingness to become conscious, of the rules, routines and procedures each follows (Gulati and Singh, 1998).

Too much control however, will have a negative impact on the continuation of trust (Dekker, 2003). Depending on the situation, a combination of both is needed, which depends on the level of relational uncertainty - i.e., the probability of opportunistic behavior and business uncertainty. Relational uncertainty asks for more control, but business uncertainty for more trust (Das and Teng, 1998; De Man, 2006). Trust and control are considered as parallel concepts and their relationship is of a supplementary character in generating confidence. In addition, control mechanisms have an impact on the trust level, which moderates the effect of control mechanisms in determining the control level (Das and Teng, 1998). Madhok (1995b) argues that trust and control are substitutes: they form two different orientations for management, namely a relation-based approach (trust) and contractual-based approach (control). In this case, it can be stated that the more trust there is, the less control is needed. Inkpen and Currall (2004) came to the same conclusion.

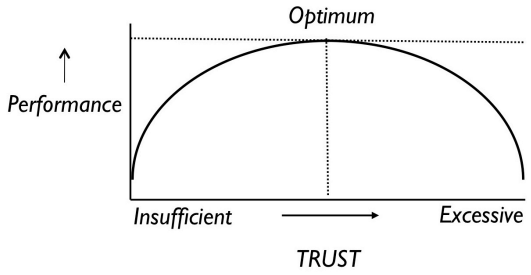
At the same time, if formal controls are used extensively, the development of trust tends to be slower (Inkpen and Currall, 2004). Das and Teng (1998) conclude that trust and control are complementary: trust may not simply be a substitute for control; managers combining formal contract with a high level of relational governance achieved higher exchange performance. Poppo and Zenger (2002) and Luo (2002) drew a similar conclusion: more performance can be expected in cases where, in addition to trustworthy cooperation, more specific contracts were made which contained more contingency terms.

Once the alliance partners trust one another, trustworthiness should be maintained. Trust between alliance partners can be created and expanded**.** Low levels of trust will clearly have a negative impact on alliance performance, as

[13] Also mentioned by Ring and Van de Ven (1992), Nooteboom et al. (1997), Das and Teng (1998) and Gulati (1995a, 1998).

described. At the same time, too much trust has also negative effects: it can lead to complacency, an acceptance of less-than satisfactory outcomes from a relationship (Gargiulo and Ertug, 2006). Furthermore, too much trust can lead to betrayal, blind faith with risk of malfeasance, less information exchange between partners, or unnecessary obligations (Gargiulo and Ertug, 2006). This is illustrated in Figure 4.6.

Figure 4.6: Performance and trust



Source: Gargiulo and Ertug, (2006).

We define our variable '*trust*' as (1) the mutual intent to disclose information in an accurate and timely fashion, (2) the extent to which obligations are met, (3) the mutual inclination to give responsibility to one another and (4) the willingness and ability to share expertise.

Based on above-mentioned arguments, we suggest

Hypothesis 5: TRUST

The relationship between trust

and performance of a co-innovation alliance is hill-shaped.

4.4.2 CULTURAL FIT[14]

Culture is often cited as a reason for alliances not accomplishing their objectives. According to Leisen et al. (2002), seventy-five percent of alliance failures can be attributed to various types of culturally related problems. Without cultural sensitivity, an alliance might run a large risk of failure (Child and Faulkner, 1998). In addition, the cultures of the partners should be compatible (Callahan and MacKenzie, 1999; Duysters and Heimeriks, 2002a). Incompatibility between cultures may lead to poor communication, resulting in ineffective decision-making, complicated problem resolution and inadequate leadership styles. Therefore, understanding the cross-cultural patterns, and dealing with them effectively, should be considered essential (Prahalad, 1998).

Hofstede (1989: 390) defines culture as *"collective programming of the mind that distinguishes the members of one group or category of people from another."* Different layers of culture can be distinguished from one another, which vary from very implicit and in-depth, such as basic assumptions, norms and values, to explicit and superficial, as in specific jargon, status symbols, and rituals (Hofstede, 1980; Trompenaars and Hampden-Turner, 1998). The analysis of cultures can be made at different aggregation levels, ranging from national, organizational or group (or team), or even personal level. All these levels of culture will influence the outcome at the level of an individual alliance (Parkhe, 1991). We focus on the national and organizational level, which we will discuss briefly. At the national level, cultures vary on dimensions referred to as power distance, uncertainty avoidance, individuality, masculinity, and time orientation (Hofstede, 1980). At the corporate level, parameters are used such as communication, information evaluation, decision-making routines, leadership style, problem-solving style, conflict management style, time orientation and employment duration (Parkhe, 1991; Isaksen and Tidd, 2006; Trompenaars, 2007).

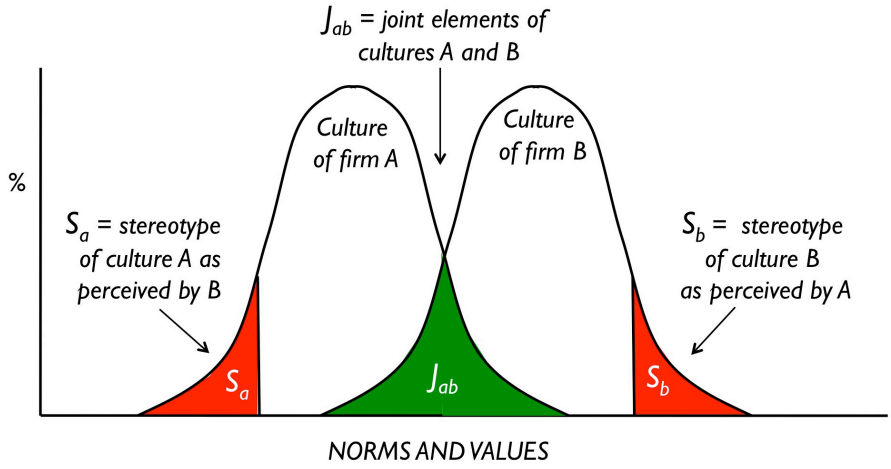
Cultural values are often reported with a high level of generality. This is unjustified, due to the fact that individuals may not act according to the group's perceived standards. To a certain extent, values and practices are shared, but at the same time, values and practices vary within groups and between groups following a normal distribution (Trompenaars and Hampden-Turner, 1998), as illustrated in Figure 4.7. Groups A and B have different norms and values; at the same time they have certain cultural elements in common (C_{ab}). There is a risk

[14] This variable is grounded in the literature on cultural fit (contingency theory), protection of knowledge and core rigidities (resource-based view), and aspects of cultural differences (organizational learning theory).

however, that the groups refer to one another in extreme stereotypes (s_a and s_b). For instance, the American and French cultures differ from one another; Americans might stereotype French as arrogant, flamboyant, hierarchical and emotional, whereas the French view the Americans as naïve, aggressive, unprincipled and workaholics.

Culture is not a static construct; cultures will change in due course through the influences of multiple interactions with other cultures (Trompenaars and Hampden-Turner, 1998; Leisen et al., 2002). In addition to this, cooperation with other cultures may lead to friction. The level of cross-cultural tension varies in the course of relationship-building processes; differences in cultural values are more apparent in the early stages of relationships than later on (Moss Kanter and Corn, 1994). During the cooperation, rather than stereotyping others, who are culturally differently programmed, partners become more aware of their cultural identity.

Figure 4.7: Joint elements and stereotypes of cultures



Source: Trompenaars and Hampden-Turner (1998).

They shift from an ethnocentric attitude - judging the other by their own standards - to a polycentric attitude - accepting and assimilating the cultural differences of the partners (Hofstede, 1983). A successful partnership replaces an initial 'us' against 'them' mentality, which is loaded with stereotypes, to a new perception of 'us' (Sonnenberg, 1992). Furthermore, people of different cultures may exchange practices, consequently adapting to one another, resulting in fewer cultural tensions.

Cultural similarity increases stability and facilitates easy problem-solving within alliances (Lin and Germain, 1998; Demirbag et al., 2007). Similarity of cultural values may reduce misunderstanding between the partners, while culturally distant partners experience greater difficulty in interacting in the acquisition of knowledge (Lyles and Salk, 1996).

At the same time, for creativity and innovation, cultural differences are to a certain extent positive, due to the fact that they enrich decision-making, and facilitate 'unlearning' or thinking-out-of-the box, therefore, managers should be aware of the different cultural identities of the alliance partners, observe cultural tensions, and pay attention to the potential advantages of those differences (Jagersma, 2005; Trompenaars, 2007). Some friction between alliance partners could be considered as being productive (Hagel and Brown, 2005). In this case, traditional business activities can be fruitfully combined with the development of exploratory new business activities simultaneously.[15] Consistent with cognitive distance theory, as described in Chapter 3, we state that cultural differences within a co-innovation team facilitate the innovation process and outcome. Too many and too deep cultural differences however, might have negative effects, which they can lead to excessive friction within in the alliances, as illustrated in Figure 4.8.

Box 4.7: Serendipity and innovation

"Half of the great innovations in the world were a result of great insight,
the other half happened by accident,
and none of them happened on schedule"

Source: McNamee as cited in Estrin (2009: 25).

Innovation means dealing with the development of new processes and products; inherently, mistakes and unexpected problems will arise. In order to address these, open and frequent communication in which information is shared effectively at all levels is essential for rapid problem-solving (Eberl and Puma, 2007; Gibbs and Humphries, 2009). In addition to this, learning from one another's mistakes and taking the necessary action is crucial (Estrin, 2009), as is illustrated in box 4.8.

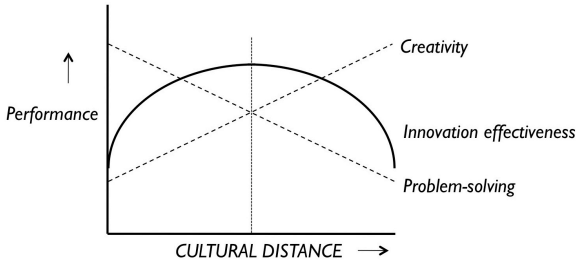
[15] This is known as ambidextrous (O'Reilly and Tushman, 2004).

Box 4.8: A culture of openness

"A culture of openness means being ready to admit mistakes and learn from them. Fear of criticism and sanctions is the cause of intellectual immobility, which is fatal for innovation departments"

Source: Eberl and Puma (2007: 43).

Figure 4.8: Performance and cultural distance



We define our variable '*cultural fit*' between the co-innovation partners by the similarity of their communication, decision-making, leadership and problem-solving styles and suggest

Hypothesis 6: CULTURAL FIT

The relationship between a cultural fit between the alliance partners and performance of a co-innovation alliance is hill-shaped.

4.4.3 ABILITY TO TRANSFER TECHNOLOGY[16]

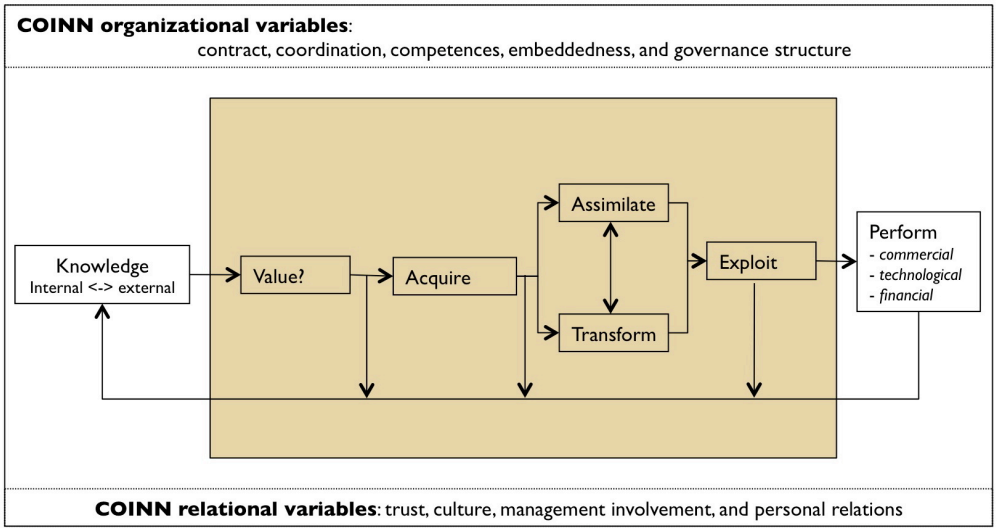
Knowledge transfer is a critical factor in the ability of a firm to innovate (Cohen and Levinthal, 1990), which involves an *inside-out* transfer, in which internally developed innovations are being commercialized, or *outside-in* transfer, were external knowledge is being internalized (Chesbrough, 2003ab, 2006). In the previous chapter, we discussed absorptive capacity as one of the key concepts of organizational learning theory, which was considered to be a conditio sine qua non for inbound and outbound innovation (Spithoven et al., 2010). We consider the ability to transfer technology as synonymous with absorptive capacity. Due to the fact that we are interested in implementation, we discuss the different components in more detail in the co-innovation context.

Technology transfer involves a set of organizational routines and processes through which firms value, acquire, assimilate or - if needed - transform and exploit knowledge. Firms sense and value opportunities, subsequently capturing them by acquisition, assimilation or transforming them into practices, which are already in use within the firm. In order to exploit them, these processes have to be managed (Crossan et al., 1999; Zahra and George 2002; Teece, 2007; Todorova and Durisin, 2007). We incorporate the process of technology transfer in our model: see Figure 4.9.

Companies evaluate their technology transfer processes, by enabling the development of new technology transfer capabilities (see the feedback loop in Figure 4.9). Firms are able to adapt their innovative business and collaborate more effectively through strong 'dynamic capabilities' (Teece, 2007). The effectiveness of technology transfer depends on common ground between a firm and its partner's knowledge base (Inkpen, 2000; Calighirou et al., 2003; Lenox and King, 2004). Alliances tend to be more successful if and when their activities are close to the in-house R&D. Incremental innovation draws primarily on *existing* knowledge bases; absorptive capacity increases the speed and frequency of incremental innovations. A *broad* range of loosely related knowledge domains facilitates radical innovation (Helfat, 1997; Vanhaverbeke et al., 2003; Lane et al., 2006). In conclusion, lower levels of knowledge transfer occur in unilateral contracts vis-à-vis bilateral cooperation.

[16] We used for this variable insights concerning the tacitness of knowledge, protection of knowledge (resource-based view and organizational learning theory), core rigidities (resource-based view), asymmetries in learning (organizational learning theory), and learning intent (organizational learning theory).

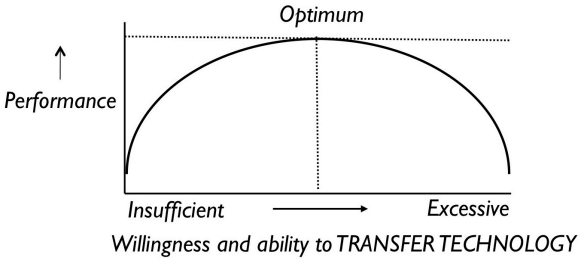
Figure 4.9: Technology transfer integrated in COINN



Adapted from Todorova and Durisin, 2007.

We define our variable '*technology transfer*' as the extent to which the partners in the alliance are willing and able to transfer knowledge to and from their partners. Too much technology transfer can have a negative effect: it may lead to uncontrolled information disclosure and a shifting balance of power, resulting in instability and underperformance of the alliance, as illustrated in Figure 4.10.

Figure 4.10: Performance and the ability in transferring technology



Based on the above, we state

Hypothesis 7: TRANSFER TECHNOLOGY

The relationship between the ability to transfer technology and performance of a co-innovation alliance is hill-shaped.

4.4.4 THE INVOLVEMENT OF MANAGEMENT[17]

Success and commitment influence one another; more commitment leads to more success, and vice versa (Blankenburg Holm et al., 1996). Managers tend to be more committed to their alliances if they are successful (Kauser and Shaw, 2004). In addition, their commitment is important for the performance of co-innovation alliances (Eisenhardt and Schoonhoven, 1996; Mortara et al., 2009). Many companies consider innovation as crucial for growth and future profitability, but due to short-term financial pressures, do not receive the necessary commitment at every level in the organization, from the top downwards (Haour, 2004; Lindegaard, 2010).

Box 4.9: Innovation and top management involvement

"Innovation needs the support of top management,
New plants need care, protection and good fertilizer,
The same applies to innovation"

Source: Eberl and Puma (2007:36).

Management involvement is important to co-innovation because management plays a strategic role in the allocation of funds or other resources to co-innovation alliances, and is in the position to obtain a resource fit with the alliance partners. Top-level managers decide upon the way a firm makes use of its partnership infrastructure and are able to reduce organizational barriers or decide upon the development of organizational competences – e.g., through selection, training or coaching of key personnel. The commitment op top-level management is especially important in establishing trust between alliance partners (Lampe and Spekman, 1997; Cullen et al., 2000). It is important that the management of all alliance partners is equally committed, for if they are not, the partnership is likely to fail (Sonnenberg, 1992; Cools and Roos, 2005).

The role of management in co-innovation projects is fourfold: making sense, role modeling, team building and support. In making sense, top managers motivate and engage their employees personally by coupling personal needs to the fundamental purpose of the organization. Increasing loyalty and motivation enhance performance due to the fact that *"people work for money but die for a cause"*.

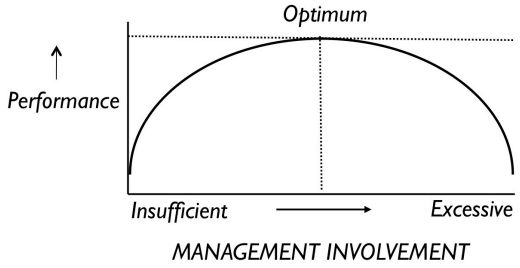
[17] This variable is grounded on insights regarding resource fit (contingency theory), structural and personal embeddedness, intensity of a network, networking capabilities (all network theory), relational capital, external cooperation, managerial support, and organizational context and barriers (all organizational learning theory).

In role modeling, top managers strive to obtain the desired mind-set, which should be shaped from the top downwards in order to promote new values into the existing corporate culture. Management serves as a role model in establishing a sense of community together with values such the importance of innovation and creativity. The third role of management is to build a strong and committed team of alliance managers. Fourth and last, they support the co-innovation activities when needed, persistently and consistently (Kets de Vries and Florent-Treacy, 2002; Aiken and Keller, 2006).

The characteristics of top managers, such as personality, background and working experience, have an impact on the performance of alliances (Pansiri, 2005). In social learning theory, the distinction is made between internally as opposed to externally orientated managers; internally oriented managers, on the one hand, believe that the outcome is a consequence of their own actions, while on the other hand, externals assume that the outcome is a result of external factors, such as chance, luck or fate, powerful outsiders, or unpredictable complex environmental forces (Wijbenga and van Witteloostuijn, 2007). Internal CEO's are more inclined to pursue a relatively innovative strategy than external CEO's (Boone et al., 1996). Internals CEO's are more inclined to search for new opportunities than externals, and seem to learn more from feedback and past experiences than externals. Furthermore, the professional background of a leader is relevant; a co-innovation team is focused on development with external partners which might benefit from a leader with a background from outside the company (Boone et al., 2005).

We define our variable '*management involvement*' as the extent to which the top managers of the alliance partners are involved in the co-innovation alliances. Such involvement can become counter-productive; management *intervention* during the innovation process has a negative impact on project performance, while management *facilitation* leads to higher performance (Bonner et al., 2002: 238). Excessive involvement by top managers may lead to too much dependency on management, and less flexibility and motivation on the part of the co-innovation team, as is illustrated in Figure 4.11.

Figure 4.11: Performance and management involvement



Therefore, we formulate

Hypothesis 8: INVOLVEMENT OF MANAGEMENT

The relationship between involvement of the management and performance of a co-innovation alliance is hill-shaped.

4.4.5 INTERPERSONAL RELATIONSHIPS[18]

Personal attachments contribute to alliance performance, which should be maintained at several hierarchical levels during the various stages of the alliance. The success of co-innovation alliances depends not only on the hard side of alliance management, such as financial or operational issues, but also on the soft side: the development and management of relationships within the alliance. A balance between structural and personal embeddedness is preferable, as this stabilizes an alliance (Seabright et al., 1992; Madhok, 1995a; Child and Faulkner, 1998), therefore, building and maintaining interpersonal relationships with counterpart partners is important. More effective co-ordination, communication or conflict-resolution can be achieved with the help of interpersonal relationships (Kauser and Shaw, 2004; Trompenaars, 2007). The interpersonal skills of key personnel are essential in this situation, which can be achieved by the selection of new personnel with the appropriate credentials, or the training and coaching of existing personnel in order to develop their capabilities further (Stober and Grant, 2006).

[18] This variable is based on structural and personal embeddedness, intensity of a network and networking capabilities (all network theory), external cooperation, motivational barriers and relational capital (all organizational learning theory).

Box 4.10: Know-how and know-who

"Success is the result of
not only what you know but also who you know.
Intercompany relationships are a key business asset,
and knowing them is an essential managerial ability"

Source: Moss Kanter (1994: 108).

We discuss several aspects of personal relationships at several hierarchical levels during the various phases of the alliance.

Personal relationships affect several aspects of the co-innovation alliance because co-innovation alliances often demand intensive interaction between the various partners. During the innovation process, disagreements are almost inevitable. When conflicts are not effectively resolved, the cooperation will become less effective and the innovation is likely to fail. In contrast, when conflict resolution processes are properly managed, the cooperation will be energized (Lin and Germain, 1998). Personal relationships are vital in problem-solving, stabilizing and strengthening the inter-firm partnership. Furthermore, they facilitate knowledge transfer between alliance partners. The positive effects of relational-based governance compared with contractual-based governance are especially important in situations of high pressure or environmental turbulence (Madhok, 1995a; Lee and Cavusgil, 2006) and in dyadic alliances (Garcia-Canal et al., 2003).[19]

It is preferable to maintain personal relationships at several hierarchical levels between the co-innovation alliance partners. Companies with strong personal relationships across the board share information widely, and tend to create more productive external relationships at several levels – i.e., at the strategic, tactical, operational, and interpersonal level. Managers should, to a certain extent, be given the freedom to build and maintain relationships with their alliance partner's counterparts. However, freedom to act may be difficult for tightly managed companies with detail-oriented managers; in these cases, communication and acquisition of knowledge are restricted. Because of strict internal barriers, alliance partners might face problems in realizing the full potential of their relationships (Moss Kanter, 1994). Maintaining multi-level relationships between different organizations is highly interactive and therefore complex, due to the fact that the counterparts might possibly need to act within contradictory contexts. In order to deal with these complexities, the managers involved should

[19] In multi-partner alliances, the effect of personal relationships is considered to be weaker.

be highly adaptive (Boddy et al., 2000). Janowicz-Panjaitan and Noorderhaven (2008) conclude that informal learning behavior, such as spontaneous interaction and knowledge sharing, has a positive effect on the inter-organizational learning of tacit knowledge, while too much formal learning behavior - e.g., programmed events and visits, might become counter-productive at higher levels.

Box 4.11: Relationships evolve

"Relationships between companies begin, grow, and develop – or fail –
much like the relationships between people.
Just as in romances, alliances are built on hopes and dreams.
Establishing many interpersonal relationships between partners
helps resolve small conflicts before they escalate"

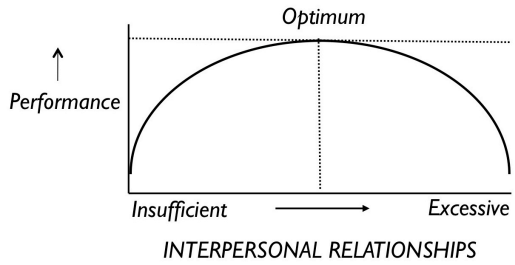
Source: Moss Kanter (1994: 99).

Personal relationships are crucial in several phases of the alliance (Kauser and Shaw, 2004; Leenders et al., 2007). Not only does the social structure affect inter-firm alliance formation (Gulati, 1995b), personal ties also play a major role in the maintenance or prevention of the dissolution of alliances (Seabright et al., 1992). During all phases of an alliance, formal (structural) and informal (social-psychological) processes interact. Ring and van de Ven (1994) distinguish three phases: a negotiation, commitment, and an execution phase. At the start of the relationship, in the negotiation phase, alliance partners develop expectations about one another's motivations, and investigate terms and procedures for a potential relationship; in this phase, bargaining is usually formal. Later, in the commitment stage, partners might reach a mutual agreement, both formally and psychologically, when they feel more committed to the relationship. Finally, in the execution stage, the terms and governance structure are established and implemented. If the unexpected should happen within the co-innovation cooperation, misunderstandings and conflicts among the parties are almost inevitable, which can be a reason for rethinking the terms of the relationship through renegotiation, followed by new commitment and execution. When there are significant imbalances between the formal and the informal processes in the negotiation, commitment and execution stages, the likelihood of the dissolution of the alliance is increased (Ring and van de Ven, 1994). It is therefore important to build sound interpersonal relationships between the partners of an alliance during an extended courtship period - i.e., before the alliance is created. Staffing the alliance with managers who are able to interact properly with partners is

probably the single most important task in creating new alliances (Lei and Slocum, 1991).

Personal relationships strengthen one another, but the contribution of these attachments to performance diminishes as the attachments become closer (Luo, 2002). Personal relationships may become counter-productive, if they become too close and informal, because the loyalty of alliance managers might shift to other partners (Hamel et al., 1989). Too much informality will a have negative effect, as it can lead to excessive dependency on personal relationships, complacency, and acceptance of less-than-satisfactory outcomes from the relationship (Gargiulo and Ertug, 2006) that have to be managed in order become or remain productive. This is illustrated in Figure 4.12.

Figure 4.12: Performance and personal relationships



We define our variable *'interpersonal relationships'* as the extent of informality between alliance partners. Informal contacts arise from people's need to relate to one another (Kratzer et al., 2005). Based on the above, we have

Hypothesis 9: INTERPERSONAL RELATIONS

The relationship between informality

and performance of a co-innovation alliance is hill-shaped.

4.5 SUMMARY AND CONCLUSIONS

In this chapter, we discussed each driver by summarizing the forces that enhance or limit performance, which motivate the expected relationship with performance. We used four theoretical domains to construct our performance organizational and relationship variables, as listed in Table 4.3.

We predict positive correlations to co-innovation performance of *balanced competences*, and *governance fit*. In addition, we expect hill-shaped relations to performance of *embeddedness*, *coordination need, trust, cultural fit, ability to transfer technology, involvement of management and interpersonal relationships*. Last, we expect a negative relation of performance to the need to agree on details ex ante (*contract need*). We summarize our preliminary hypotheses of the expected relations between our drivers and performance in Figure 4.13.

Figure 4.13: Summary of preliminary hypotheses

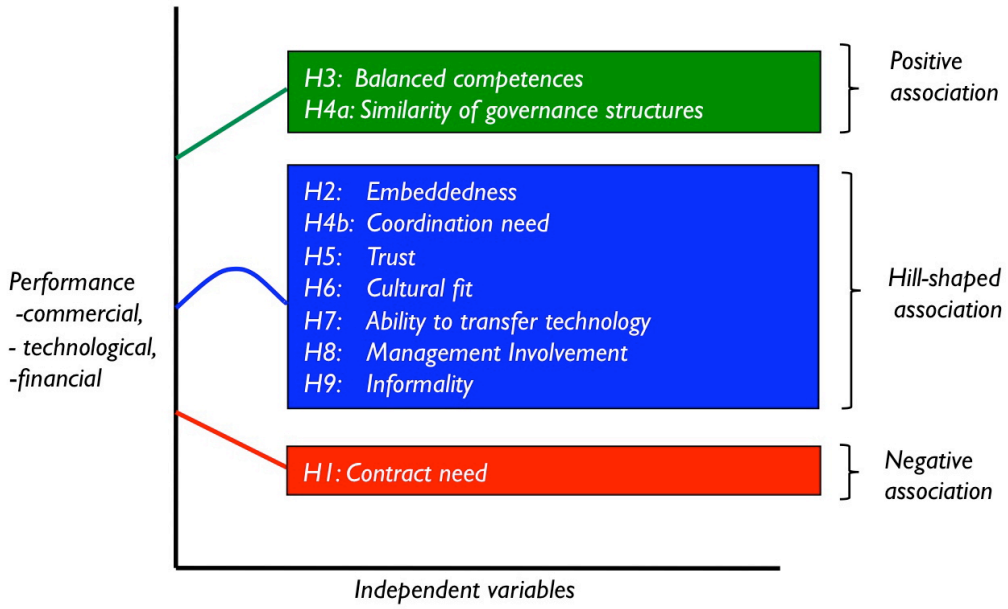


Table 4.3: Theoretical contribution to the performance drivers

THEORY	FACILITATING OR BLOCKING FACTOR	ORGANIZATIONAL VARIABLES				RELATIONAL VARIABLES					CONTROL VARIABLES		
		CONTRACT NEED	EMBEDDEDNESS	BALANCED COMPETENCES	COORDINATION NEED	TRUST	CULTURAL FIT	TRANSFER OF TECHNOLOGY	MANAGEMENT INVOLVEMENT	INTER-PERSONAL RELATIONS	ALLIANCE CHARACTERISTICS	MARKET CONDITIONS	STRATEGY
NETWORK THEORY	*Aim of a network*				X								X
	Size of a network		X								X		
	Diversity of a network and interdependency of its partners		X	X									
	Structure of a network		X										
	Context of a network											X	
	Intensity of a network								X	X			
	Position in a network		X	X						X			
	Networking capabilities								X	X			
	Structural and personal embeddedness					X			X	X			
	Dynamism of a network											X	
RESOURCE-BASED VIEW	*Experience & specialization*		X										
	Selection-training-coaching								X	X			
	External cooperation		X										
	Tacitness of knowlede							X					
	Dynamic circumstances											X	
	Protected knowledge					X	X	X					
	Core rigidities						X	X					X
CONTIN-GENCY TH.	*Market fit*											X	X
	Strategy fit												X
	Resource fit			X	X				X				
	Cultural fit					X	X				X		
	Organization fit	X			X						X	X	
ORGANIZATIONAL LEARNING THEORY	*Learning intent*							X					
	Managerial support								X				
	Relational capital					X			X	X			
	Capabilities			X				X					
	Org. context and barriers	X			X	X			X				
	Motivational barriers					X		X		X			
	Divergent goals												X
	Protection of knowledge	X			X	X		X					
	Cultural differences						X						
	Unlearning							X					

5. RESEARCH DESIGN

5.1 INTRODUCTION

In this chapter, we motivate our methodological choices and their implications for research design, our research activities, analysis techniques, and data collection. In addition, we discuss the appropriateness of several analysis techniques: exploratory factor analysis, confirmatory factor analysis, and structural equation modeling. Before analyzing our data, we screen our base dataset on missing values, outliers, sample size, and normality. We motivate the choice of three groups of control variables (regarding the alliance, market, and strategy) as covariates in our analysis. After screening our data, we construct our definitive COINN-model.

The scope of our research objectives and scope imply three methodological choices: to choose between qualitative or quantitative research, to use secondary or primary data, and how to deal with cross-classified data.

The first choice is to decide upon the use of secondary data or to collect primary data. Some empirical studies on alliance performance and innovation management use existing (secondary) sources to test their hypotheses (Gomes-Casseres, 1987, 1989, 1996), others collected data via the combination of newly developed and existing databases (Kogut and Singh, 1988; Agarwal, 1994). In our case, secondary data containing information on the perceptions of managers regarding co-innovation and accompanied organization and relationships were not available; neither was data regarding the underlying motives of those managers. Given the specific nature of our research - success indicating factors and processes of co-innovation alliances – no data could be found in any existing database. Consequently, we had to develop our own database.

Following this choice, we decided upon the industries and countries to be researched. The multi-industrial scope involves certain research obstacles - e.g., regarding different norms, business definitions or business models (Kumar and Nti, 1998; Parkhe, 1993b). Based on our literature review and practical considerations regarding approachability, we decided to focus on certain industries, which we group in three categories: (a) the food industry, (b) the manufacturing industry, and (c) service industries. Because of time and budget constraints, as well as issues of access, we limited our research to the Netherlands and Belgium.

The second methodological issue involves the choice between a certain qualitative or quantitative approach. In our research, we measure the perceptions of managers. Managers use subjective judgments on which to base their

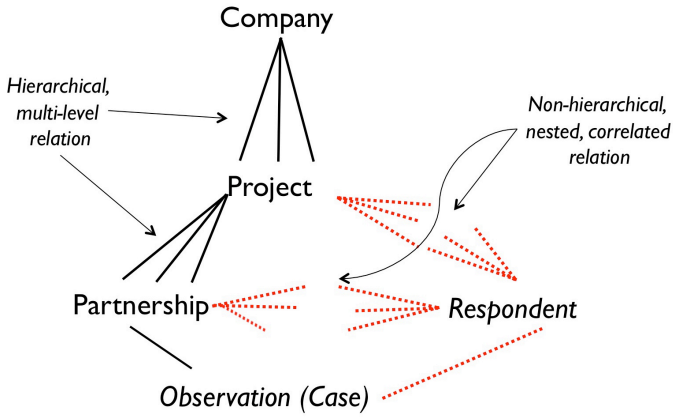
decisions (Bell, 1996). For collecting subjective or perceptual data, qualitative methods can be used - e.g., case studies - or quantitative methods, such as surveys and questionnaire-based interviews. The research objective is there to develop and test a theoretical and evidence-based model. This testing leads to a quantitative approach. For large-scale studies, surveys are widely used. The topics of our research are considered to be complex - assessment of the market environment of the co-innovation projects - and sensitive - for instance, assessment of personal relationships with partners. Such complex and sensitive items can easily lead to misinterpretations or non-response in a large survey (Malhotra and Birks, 2007). We have therefore chosen to use questionnaire-based interviews. however, due to time and budget constraints, this means that the dataset will be limited. In order to deal with these constraints, we decided to conduct multiple interviews with our respondents, by obtaining multiple observations per respondent.

The third methodological choice is how to deal with the cross-classified data in our research. The problem of correlated data is common in the social sciences (Ghisletta and Spini, 2004). In our research, relationships at several levels interact with one another: interpersonal relationships ("micro-relations") - e.g., between project managers of the alliance partners - influence to a certain extent the performance of the co-innovation alliance at the "macro level". These micro-macro relationships have to be studied in a multi-level approach (Snijders and Bosker, 1999; Zaccarin and Rivellini, 2002). however, not all our data has a purely hierarchical, but rather a cross-classified structure. Hierarchical relationships identify unique combinations, while non-classified data are not uniquely but simultaneously linked to other levels. In our research, 93% of the responding companies and 77% of the respondents supplied multiple observations, resulting in a cross-classified database, therefore our research has a mixed hierarchical (multi-level) and non-hierarchical (cross-classified) structure, which will be discussed in Section 5.2.

5.2 RESEARCH MODEL AND DESIGN

Our research is aimed at studying the effects of co-variates *across* groups or clusters rather than within a specific group or cluster. Figure 5.1 visualizes the nature of our dataset.

Figure 5.1: Mixed hierarchical and non-hierarchical relationships



Company X is involved in co-innovation Projects Y^1, Y^2, Y^3 in cooperation with one or more Partners Z^1, Z^2, Z^3. Multiple Respondents reviewed a specific Project, while some Respondents judged several Projects. Multiple Respondents reviewed a specific Partnership, while some Respondents judged several Partnerships. Every Observation is attributed to a single Partnership, every Partnership to a single Project, and every Project to a single Company.

Unique hierarchical relationships can be found between Company and Project, Project and Partnership, Partnership and Observation, and Respondent and Observation. A Project is uniquely attributed to a responding Company, a specific Partnership to a unique Project, and a specific Observation to only one Respondent (because his or her perception is measured). Non-hierarchical (cross-classified) relationships exist between Respondent and Project and between Partnership and Respondent; Companies usually supplied several Projects, for some Projects multiple Partnerships were reviewed and most Respondents submitted more Observations on different Projects. Many Projects are not uniquely related to Respondents, and vice versa. The same applies to Partnership: many Partnerships are not uniquely related to Respondents, and vice versa.

Because of this mix of hierarchical and correlated or nested relationships, our analysis has a multi-level and cross-classified character. Within cross-classification, the effects of different "contexts" are studied, and within multi-

level the performance at a higher aggregation level (Zaccarin & Rivellini, 2002; Field, 2009). When data are correlated (or nested) within a cluster of observations in a particular group, inefficient or biased estimates of the regression coefficients may lead to incorrect research conclusions (Ballinger, 2004). In order to adjust for correlation within the groups of correlated data, we tested the robustness of our data, with the use of a robust variance estimation technique, known as the Huber/White test: the "robust cluster" command in Stata.[1] In this routine, observations *within* a cluster are considered to be non independent, unlike clusters of observations that are considered to be independent (Stata, 2009).

The degree of correlation of the observations can also be measured by the Intra-Class Correlation (ICC) statistic, which is a factoring correlated (or contextual) variable. The ICC is a measure of the extent to which members of the same group are similar to one another rather than to members of other groups (Cohen et al., 2003; Tabachnick and Fidell, 2007). The ICC represents the proportion of the total variability in the outcome that is attributable to the correlated classes or clusters (Field, 2009; Cohen et al., 2003). The ICC measures whether the scores from different groups are more discrepant from one another than scores within the same group (Cohen et al., 2003). If the ICC is small, low variability can be attributed to a context variable and the effect of the context variable will be small (Field, 2009). The ICC ranges from zero (complete independence) to one (complete dependence). ICC can be considered as a measure of the reliability of an evaluation, but also as a measure of the reliability of the group mean (Bliese, 2000; Bogaert et al., 2009). *Within*-group effects can be completely different from *between*-group effects (Snijders and Bosker, 1999). When analyzing *between*-group effects, the variability of the aggregated micro-level units will be neglected, and the effects of within-group variability will be lost. We have not used either of these ICC-concepts because our dataset con-

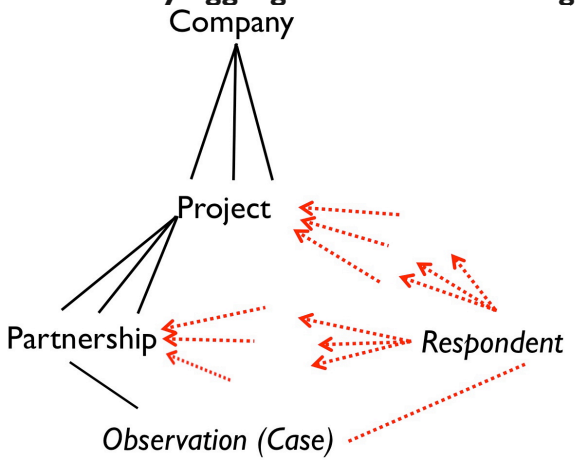
[1] Zorn (2006) discusses Huber/White and the Generalized Estimating Equations technique (GEE). With GEE the existence of fixed effects of non-independent data can be measured and the effects of co-variates *across* groups or clusters can be tested. GEE indicates the effect if the average response of a cluster changes (Zorn, 2001; Ballinger, 2004; Bogaert et al., 2009). For adequate use of GEE however, the mean model should be correctly specified, possible missing values should occur completely at random, the number of clusters sufficient, and the observations in different clusters independent, although within-cluster observations may correlate (Zorn, 2001; Ballinger, 2004; Ghisletta & Spini, 2004). Zorn (2006) concludes that both techniques represent advantages in dealing with correlated data and considers the differences between GEE and Huber/White less important than the choices concerning the unit on which observations are grouped.

sists of clusters involving few observations. Due to this intra-class variability, many classes will be close to zero, and ICC might not serve our aim of testing the robustness of our regressions.

Our research design has elements of a multi-level analysis, in which the correlation structure between the levels should be fully specified. Our interest is to study the variability *across* rather than *within* certain clusters at the level of co-innovation projects, partnerships and companies. The variability across respondents however, is not our prime research interest. In order to deal effectively with our mixed structure, a common procedure with multi-level data is necessary in order to aggregate the micro-level data to the macro level (Snijders & Bosker, 1999). We therefore aggregated the data of multiple respondents to the level of project-partnership, and checked the robustness of our regression parameters with Huber/White. In doing so, we made a comparison of the regression results of several subsets of our data. First, we took an a-select sample "1" of one observation per company (N = 51) of our base dataset with correlated data. It can be assumed that no dependency on context variables is present in this sample. Second, we took the scores of partnerships with only one respondent (N =118), and combined these with aggregated scores of the partnerships with several respondents (39 observations of 20 partnerships). We then made the four subsets "2", containing the single observations *plus* the *average* scores (subsample 2a), the *maximum* scores (subsample 2b) (subsample 2c), the *minimum* scores, and the *(Maximum-Minimum)* scores (subsample 2d) of multiple respondent partnerships, respectively.

This aggregation is illustrated in Figure 5.2. For the sake of robustness, all regression analysis will be performed on all five datasets.

Figure 5.2: Partly aggregated research design



5.3 RESEARCH ACTIVITIES

In order to achieve our research objectives, we reviewed the applicability of insights from research on joint ventures and strategic alliances. We then integrated insights from different theories that are relevant for co-innovation into our COINN-model: the resource-based view, contingency theory, organizational learning theory and network theory.

Our research process involves the development of the conceptual COINN-model, the design of a questionnaire, conducting survey-based interviews, statistical analysis and ultimately, construction of the semi-definitive model, which is based on the above-mentioned activities together with feedback from senior managers.

We prepared our conceptual model, based on a review of the literature on joint ventures, strategic alliances, and innovation management in combination with open interviews with senior managers, consultants and researchers. We employed their expertise and experience as input for the COINN-model. The managers were director strategic business development, director emerging technologies, vice-president innovation, manager group research, director connectivity program, director advanced technology center, and director collaborative innovation (see appendix A). We developed a questionnaire, based on specific guidelines (Tabachnick and Fidell, 2007; Hair et al., 2010)

The use of a self-reporting questionnaire in order to collect data from the same participant can potentially cause common-method variance (CMV), which may generate systematic measurements errors (Chang et al, 2010)[2] because CMV potentially affects single-method research. We undertook several procedural and statistical remedies in order to reduce potential bias due to common-method variance.

First, in the test phase we investigated whether the data of the dependent, independent and control variable data could be obtained from different and multiple sources (Podsakoff et al., 2003). Due to time and budget constraints, we decided to use single sources.

[2] Common-method variance (CMV) is defined as "the variance that is attributable to the measurement method rather than that of the constructs the measures represent" (Podsakoff et al., 2003: 879), or the bias amount of assumed covariance shared among variables due to the common method used in collecting data. Sometimes such measurement errors are overstated (Graham, 2009), or difficult to detect (Malhotra et al, 2006). There are numerous sources of CMV: social desirability, scale length, ambiguous working, and more (Malhotra et al, 2007).

Second, in order to avoid social desirable or benign responses, respondents were guaranteed anonymity and confidentiality, if so desired through a written agreement (Podsakoff et al., 2003; Chang et al., 2010).

Third, in order to reduce item ambiguity, we avoided vague concepts and pretested the draft questionnaire in ten semi-structured interviews with senior managers and innovation experts. In the interviews, we tested whether the questions and definitions were easily understood and interpreted uniformly, and whether the requested information was available. After the tests, we clarified the instructions, and skipped some questions regarding specific financial performance ratios, because of different interpretations in different industries or lack of availability. Survey instructions accompanied the questionnaire, including definitions and norms (Krishnan et al., 2006).

Fourth, as procedural remedy to avoid CMV, we separated scale items of the dependent and the independent variables, which avoided the likelihood of respondents guessing potential relationships between the dependent and independent variables (Parkhe, 1993a).

Fifth, we used a common medium to obtain our measurements in order to avoid biased covariation among our variables; each respondent followed the same guidelines and instructions. In order to obtain consistency in the answers and to avoid misinterpretations, the same interviewer carried out all interviews.

Sixth, in order to avoid "mood state" bias, the questionnaire and necessary interviewing time was restricted.

Apart from these procedural ex ante remedies, we undertook an ex post statistical test, namely the Haman's one-factor test,[3] which checked whether the data could be largely attributed to a single factor. We conducted an Exploratory Factor Analysis of all items in order to observe whether one single factor accounted for a majority of the covariance (Chang et al., 2010: 180), as is listed in Table 5.1. The first (largest) factor accounts for only 10.1% of the variance, which implies that CMV is unlikely to be a major issue.

Respondents were asked to give their perception on statements and mark their opinion on continuous scales. In order to obtain a good measure of the performance of the co-innovation projects, only projects that originated at least two years earlier were studied.

The final questionnaire consisted of six sections - general characteristics, market, strategy, organization, relationships and performance - with in total 104 items, including control variables. The questionnaire (see appendix A)

[3] This test is considered to be incomplete because it might be insensitive and, therefore only supplies an indication of possible CMV (Podsakoff et al., 2003; Chang et al., 2010).

consisted of some introductionary questions, 10 discrete 1-5 scales (4 nominal, 6 ordinal) and 86 continuous interval scales ranging from 1 to 10. All scores were measured with the same measurement tool[4] at an accuracy of 0.1 cm.

We then obtained 159 survey-based observations of 109 projects from 81 senior managers at 51 innovative companies in the Netherlands and Belgium (see Appendix D). This field research was followed by statistical analysis to test the hypotheses and to estimate the explanatory power of the underlying model.

5.4 DATA COLLECTION

In this section, we discuss the sources of data, and the numbers of participating companies and partnerships in our research.

We obtained observations from several access gateways. Through our own network of previous work contacts, we received 65 observations from 38 projects. During the research, we were introduced to network contacts, which resulted in another 49 observations from 33 projects. Furthermore, we organized a workshop, which resulted in 14 observations taken from 13 projects. Another 20 observations relating to 16 projects were obtained through three institutions in the Northern Netherlands[5]. Last, a further 11 cases from 9 projects were collected via the networks of respondents,

Fifty-one companies contributed to our research, which supplied 137 partnerships. The sizes of the responding firms and their partners in these partnerships vary, as visualized in Figures 5.1 and 5.2. The largest proportion of the observations are derived from companies with sales between € 250 million and € 2.500 million (39% of the responding companies and 24% of the partner companies) and 250 and 2.500 employees (38% of the responding companies and 25% of the partner companies). On average, responding companies supplied 3.6 observations.

The largest proportion of observations (25%) were derived from companies that contribute two observations. One company supplied twenty observations, from twelve partnerships (8.8% of the total of partnerships). We observed the influence of this company on the regression results in our analysis. The headquarters of the companies and their partners are mostly located in the Netherlands (80% of the respondents, and 62% of the project partners). In

[4] Floor, thank you for your accuratly measuring of this!
[5] These institutions are the province of Groningen, Samenwerkingsverband Noord Nederland (SNN), a partnership of three provinces in the Northern Netherlands aimed at strengthening the economic position of these provinces, and Technologie Centrum Noord Nederland (TCNN), an innovation support organization in the Northern Netherlands.

addition, Belgium hosts 8% of the respondents and 10% of the project partners. The headquarters of the partners are located in the Netherlands (63%), Belgium (8%), and the USA (8%). Other locations are Germany, Canada, Japan, Australia, Switzerland, and Scandinavia.

Figure 5.3: Size of responding companies and partners (sales)

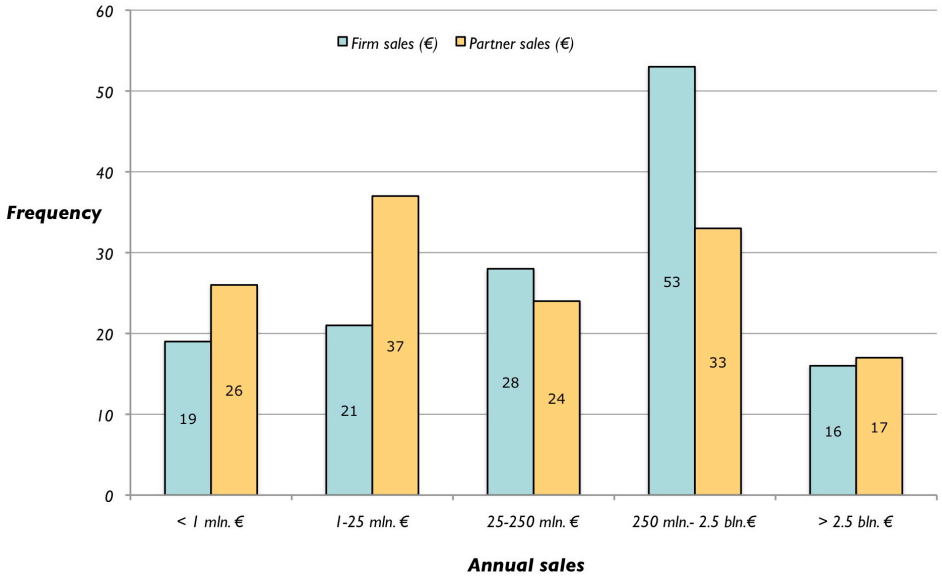
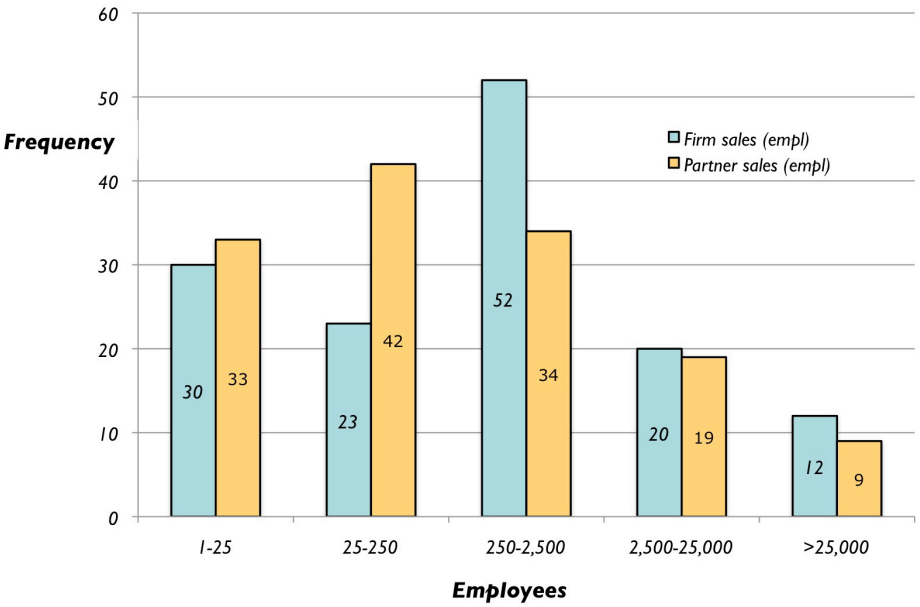


Figure 5.4: Size of responding companies and partners (employees)



5.5 ANALYSIS TECHNIQUES

Based on the related literature, we endeavor to analyze the underlying structure of organizational and relational factors on the performance of co-innovation projects. In our research, we conducted an Exploratory Factor Analysis (EFA). In contrast to other data-reduction techniques such as Confirmatory Factor Analysis (CFA), EFA distills the common variance in the factor matrix, without forcing prior limitations on the observed variables. EFA uncovers underlying structures of variables, by defining factors in terms of sets of variables. As a result, every variable has a loading on each factor (Hair et al., 2010). This differs from CFA, which tests a structured against an unstructured covariance matrix (Ullman, 2006) and consequently, enforces prior limitations on the observed variables. This requires a preceding specification of variables into each construct, due to the fact that loadings are estimated where variables are related only to constructs, without cross-loadings (Hair et al., 2010).

In Structural Equation Modeling (SEM), factor analysis and multiple regression analysis are combined to estimate a series of interrelated dependence relationships simultaneously. This approach has certain advantages, in that its complex relationships can be analyzed by a combination of both discrete and continuous variables, whether observed or latent (Tabachnick and Fidell, 2007). At the same time, SEM is more sensitive to deviation from multivariate normality and strong kurtosis in the data than other multivariate techniques, and requires a large sample size (Hair et al., 2010). In order to minimize problems with multivariate normality, Hair et al. (2010) recommend 15 observations for each parameter estimated in the model, and a sample size of at least 200 to provide a sound basis for SEM estimation. As explained in Section 5.4, our database consists of 137 aggregated partnership observations, which is sufficient for models with a maximum of 9 parameters. As our model transcends this number, we do not match the criteria laid down by Hair et al. (2010) for SEM. Based on the above, in our context we conclude that CFA and SEM are inappropriate statistical tools. We have chosen to conduct data-reduction with EFA and multivariate regression with Huber/White, including robustness checks for the five above-mentioned datasets. The results of these analyses will be reported and discussed in Chapter 6.

For our statistical analyses, we made use of the statistical packages SPSS for Mac, version 17.0, Stata for Mac version 10.0, and Excel for Mac, version 12.2.0.

5.6 CONTROL VARIABLES

We included three groups of control variables regarding the alliance, the market and strategy as covariates in our analysis. The control variables are listed in Boxes 5.1, 5.2, and 5.3, respectively.

Box 5.1: Alliance control variables

1. *Respondents' role*
2. *Industry*
3. *Project duration and project life cycle*
4. *Number of partners*
5. *Partner nationality*
6. *Input of the firm and its partner*
7. *Size of the firm and its partner (in absolute, relative and efficiency terms)*
8. *Innovativeness of the firm and its partner*
9. *Importance of the project (as perceived by the firm and its partner)*
10. *Initial conditions*

Fist, we discuss *alliance control variables*. We assessed the influence of the *role* that respondents have in the co-innovation alliance. Respondents indicated whether their role is project manager, strategic manager, advisor or a mixture of these roles. Project managers conduct operational day-to-day activities with the partner and might develop a greater personal loyalty, leading to a more positive evaluation in contrast to strategic managers, or advisors, who might engage in more marginal roles. We constructed separate dummy variables for the roles of the respondents.

We took *industry* as a control variable, because variations in co-innovation performance may be expected in different industries or during various economic cycles. We categorized our projects into three groups: the food and healthcare industry[6], manufacturing[7] and services industries.[8] The food and healthcare industry is less affected by major economic cycles, compared to the

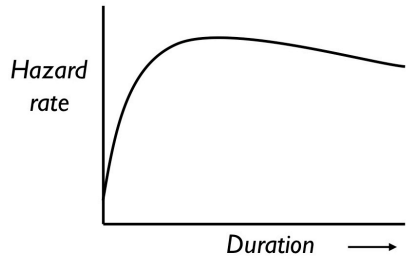
[6] Consisting of projects in the market segments food ingredients, pharmaceuticals, food and nutrition, healthcare, agriculture and food chemicals, and fast-moving consumer goods.
[7] Consisting of projects in the market segments ICT and electronics, defense, durable energy, non-food chemicals, consumer non-food industry, and industrial non-food industries.
[8] Consisting of intangible activities in the market segments logistics, utilities, consulting and financial services and media.

other groups. The motivation to cooperate varies according to the industry. In manufacturing industry, open innovation is employed to gain access to new technologies, while in the food and healthcare industry, it is used to find new ideas which generate new products or reduce the time to market, while in service industries, the nature of business is very open (Mortara et al., 2009). Innovating services differs from innovating products. Innovation in services industries differs from innovation in manufacturing or the food industry. Customers play a more central role in service innovation due to the fact that their cooperation is needed in order to access their tacit knowledge (Chesbrough, 2011), which results in the use of another business model.[9] The three industrial groups form separate dummy variables.

We evaluated the influence of *duration of the project* based on the year it started and its life cycle, as perceived by the respondents between startup and decline phase (see appendix A for definitions). Project maturity is important due to the fact that the longer the duration of the cooperation between partners, the more willingness to adapt and trust one another can be expected, resulting in a more open style of problem-solving and a less legalistic approach (where partners rely on written agreements) in resolving conflicts. It can be expected that the longer a co-innovation alliance exists, the better its performance - for example, due to learning effects. In addition, only successful alliances are allowed to continue or be integrated into one of the organizations, while the unsuccessful will be ended or sold (Mody, 1993; Lin and Germain, 1998; Child and Yan, 2003). Park and Russo (1996) concluded that the failure rate of joint ventures will initially rise and, in the case of surviving a mid-life crisis, will decline, as is illustrated in Figure 5.5. The effective handling of a mid-life crisis is considered to be one of the greatest challenges for alliance management (Segil, 2004; Bamford and Ernst, 2005).

[9] In Porter's value chain (1985, 1998), service is considered to be a separate business activity (after sales service), whereas according to Chesbrough (2011), service should be viewed as an integrated part of every business.

Figure 5.5: Hazard rate of joint ventures



Source: Park and Russo (1996).

We measured linear and curvilinear effects of alliance longevity - i.e., the number of years since the project began, by calculating the linear and quadratic term of the duration. We included the life cycle of the alliance as a control variable because a co-innovation alliance offers flexibility, allowing firms with complementary strengths to experiment with new technological, organizational, and marketing strategies, which is especially relevant in the early stages of its life cycle (Lambe and Spekman, 1997; Cools and Roos, 2005). We measured life cycle on a Likert scale between 0 (startup phase) to 10 (decline phase).

We selected the *number of partners* in the co-innovation alliance as a control variable. Garcia-Canal et al. (2003) concluded that in a dyadic alliance, the likelihood of meeting or exceeding expectations is higher than in a multi-partner alliance. On the one hand, when more partners are involved in an alliance, an increase in managerial complexity and governance costs can be expected. On the other hand, additional partners bring complementary knowledge and resources to the alliance. In order to quantify the optimum number of partners, we calculated the linear and quadratic term of the number of partners in the partnership.

We observed the *nationality of the partner* vis-à-vis the focal firm through separate dummy variables to assess the effects of differences in national cultures (Hofstede, 1980).

The *input* of the firm and its partner is relevant because input can be considered as a measure of motivation and commitment, and thus of performance: the greater the input, the more commitment can be expected; When a firm supplies *multiple* input to an alliance, one might expect more commitment and grip on the alliance, through which a firm can steer and influence the alliance in the desired direction. We evaluated the influence of multiple input of a firm and its partner through dummy variables for commercial, technological, financial and multiple input.

We took the *size* of a firm and its partner(s), the relative size of a firm compared to its partner, and the sales per employee as separate control variables. Small and large firms may play complementary roles in alliances; small firms tend to be more flexible in developing new products, while large companies supply their alliances with their technological and market resources, specialist knowledge, and advanced production methods (Nooteboom, 1994; Dougherty and Hardy, 1996; Fornoff, 2005). Due to bureaucracy, implementing product innovation in large mature organizations might run into difficulties, especially in the case of radical innovation (Vanhaverbeke and Peeters, 2005).

In addition, *size differences* between alliances partners may have an effect on their relative balance of power; large firms might be in a better position to capture the benefits of an alliance due to their financial, technological or market power (Sinha and Cusumano, 1991), while the smaller companies might benefit from their specialized knowledge or resources. In order to limit the sharing of results, larger firms might prefer a small partner (Killing, 1982; Sinha and Cusumano, 1991). The different attitude of large multinational companies towards their alliance partners is illustrated in Box 5.2. The size of a firm can be measured by its assets (Kogut and Singh, 1988), number of employees, or average turnover (Hagedoorn and Schakenraad, 1994). Agarwal (1994) concludes that a firm's assets and number of employees generally correlate highly with one another. We therefore decided only to use the worldwide sales in Euro millions and the number of employees.

Box: 5.2: General Electric and small or large partners

"A large company like GE implements different strategies
when forming global joint ventures
with partners of comparable power, or with less powerful partners.
GE attempts to restrict the scope of the collaboration
with companies of comparable power,
but does not limit collaboration with smaller and less powerful firms,
in this case, GE allows the scope of the cooperation to be dictated by market forces"

Source: Lampel and Shamsie (2000: 598).

We measured the sizes of a firm and its partner in five classes.[10] For our calculations, we took the average of these classes and constructed new logarithmic variables. We investigated the influence of sales per employee on the performance.

We evaluated the value of *innovativeness* as this has a positive impact on future sales growth (Stuart, 2000). Innovativeness can be measured by R&D expenditures as a ratio of total revenue (Stopford and Wells, 1972; Dikova, 2005) or by patent-intensity - i.e., the total number of assigned patents compared to the average sales turnover. Assuming that innovative firms are attractive partners for strategic partnering (Hagedoorn and Schakenraad, 1994), we calculated a firm's innovativeness by way of three criteria: (a) the percentage of sales turnover spent on R&D, (b) the percentage of a firm's sales generated by products or services introduced during the last three years, and (c) innovativeness as perceived by the partner's responding management.[11] We measured the firm's innovativeness by means of ordinal scales in five classes, measuring R&D costs as percentage of total sales and the percentage of sales generated by new products or services during the three years preceding the interview. The respondents estimated the innovativeness of the partner on a Likert scale between 0 (non-innovative) to 10 (highly innovative).

We included the *importance* of the co-innovation project (as perceived by the management of a firm and its partner) as a control variable as well. One might argue that the more important an alliance is, the more commitment can be expected from the co-innovation alliance, which might correlate positively to performance. We calculated the importance of the co-innovation alliance with the use of a Likert scale between 0 (not important) to 10 (very important).

Last, we took *initial conditions* as a control variable, because they play a key role in the learning process within an alliance; unfavorable initial conditions may complicate the innovation process, due to feelings of frustration resulting in instability or underperformance (Doz, 1996). The initial phase is important because during this phase, potential future conflicts can be discussed, making the alliance more stable and crisis-proof (Baum et al., 2000). The initial conditions were expressed on a Likert scale between 0 (unfavorable) to 10 (favorable).

[10] For the definition of these classes, see appendix A (questionnaire).
[11] Hagedoorn and Cloodt (2003) conclude that, especially in high-tech industries, four indicators of innovativeness overlap largely: R&D input, patent counts, patent citation and new product announcements.

The second group of control variables is formed by market characteristics, listed in Box 5.3.[12]

Box 5.3: Market control variables

1. *Market ambiguity*
2. *Market complexity*
3. *Market or technical risk*
4. *Market uncertainty*
5. *Technological importance in the market*
6. *Market life cycle*
7. *Market turbulence*
8. *Knowledge concentration in the industry*

We can expect a high level of *market ambiguity*, as discussed in Chapter 2 due to the fact that traditional industrial boundaries are becoming increasingly fuzzy. Eisenhardt and Schoonhoven (1996) find more alliance formation in emergent or highly competitive industries, where co-innovation offers distinct advantages, leading to better performance in highly ambiguous circumstances. Our respondents judged the degree of ambiguity in the market on a Likert scale between 0 (very clear) to 10 (highly ambiguous).

The *complexity of markets* is relevant. Powell et al. (1996) state that, when the knowledge base of an industry is complex, innovation takes place in networks of learning, rather than in individual firms, resulting in better performance in highly complex circumstances, which we measured on a Likert scale between 0 (simple) to 10 (complex).

We evaluated the influence of *technical or market risk*. In the case of high risk, companies tend to lower them by combining their skills and resources with alliance partners (Doz and Hamel, 1998). Because of this, we can expect more commitment of the partners, which affects the success rate. At the same time, companies tend to control their alliances more tightly when high risk is perceived, which may result in conflict between partners resulting in lower performance (Ring and Van de Ven, 1992). We measured risk on a Likert scale between 0 (low risk) to 10 (high risk).

New advanced technologies can be developed in co-innovation alliances, which offer certain advantages in coping with *technical and market uncertainties*

[12] The definitions of these characteristics can be found in Appendix A (questionnaire).

(Krishnan and Bhattacharya, 2002; Chesbrough, 2004; Andrew and Sirkin, 2006). In uncertain circumstances, firms tend to experiment through alliances and cooperate with less hierarchical governance (Burgers et al., 1993; Mody 1993; Akhter and Robles, 2004; Van de Vrande et al., 2006). Technical and market uncertainties are related to one another; resolving technical uncertainty depends on how markets respond. In situations of high uncertainty, it is more difficult to assess business development projects due to an increased chance of unjustified approval or disapproval of projects - known as false positives and negatives (Chesbrough, 2004). By using co-innovation alliances, the uncertainties of misjudgment can be reduced with the aid of insight from external partners, which affects the intensity and structure of alliances, and consequently, their performance. Our respondents judged uncertainty on a Likert scale between 0 (low uncertainy) to 10 (high uncertainty).

It can be expected that *technological intensity* may influence co-innovation performance. Gassman (2006) concludes that, in high-tech industries, even large companies lack sufficient capabilities in coping with emerging technologies, and are therefore more inclined to cooperate, which is in line with Powell et al. (1996) and Spekman and Isabella (2000), who found a positive correlation between R & D intensity of an industry and the number of alliances in that industry. Our respondents indicated the importance of technology in the relevant market environment of their co-innovation projects on a Likert scale between 0 (technology is not important) to 10 (technology is very important).

The *market life cycle* is relevant. In emerging or growing markets, more alliance formation may be expected (Eisenhardt and Schoonhoven, 1996; Lampe and Spekman, 1998), with greater emphasis on the technological capabilities of potential alliance partners (Hitt et al., 2000a). In the early stages of new business development, companies will have a relatively low level of commitment to invest company resources by seeking more reversible and less hierarchical governance modes, as in alliances (Van de Vrande et al., 2006). Alliances are especially useful in markets with growth opportunities that a company either cannot or does not wish to pursue individually (Cools and Roos, 2005). Our respondents assessed the life cycle of their co-innovations projects on a Likert scale between 0 (young-emerging) to 10 (old- in decline).

During *market turbulence*, alliances tend to be more successful than joint ventures or acquisitions (Ernst and Halevy, 2000). At the same time, turbulence can be regarded as a source of erosion and may cause the failure of alliances (Park and Ungson, 2001; Sethi And Iqbal, 2008). In a rapidly changing environment, such as in high-tech industries, the costs of R&D in relation to sales become unaffordable - e.g., as a result of shortening product and technology life

cycles. In the case of discontinuous technological change, where existing technologies become obsolete and competitive positions consequently erode drastically, alliances become useful in acquiring complete new technologies in preference to mergers, acquisitions or internal development (Eisenhardt and Schoonhoven, 1996; Lambe and Spekman, 1997). Our respondents indicated the market turbulence on a Likert scale between 0 (no change) to 10 (fast change).

Last, we assessed the influence of *knowledge concentration* in industry and its effect on alliance formation. In industries where the sources of expertise are widely dispersed, the locus of innovation will be found in networks of learning, rather than in individual firms (Powell et al., 1996). We asked our respondents how concentrated the sources of expertise were in the industries relevant to the co-innovation project on a Likert scale between 0 (widely dispersed) to 10 (concentrated).

In the third group of control variables, we assessed the influence of strategic issues, as is listed in Box 5.4.

Box 5.4: Strategy control variables

1. *Motives*
2. *Operational flexibility*
3. *Strategic stability*

The *motivation* in entering co-innovation alliances is relevant when a fit between the strategies of the partners and the alignment of the partner's objectives with the alliance is considered to be an important success factor for alliance performance (Lorange and Roos, 1991; Parkhe 1993b; Saxton, 1997; Callahan and MacKenzie, 1999; Futrell et al., 2001; Duysters and Heimeriks, 2002a; Dikova, 2005). We evaluated the influence of strategic, technological and financial motivation. Strategic motives are, for example, the desire to increase current market power or to develop new markets. Technological motives involve learning objectives, such as the acquisition of new technological competences or the improvement of the technological portfolio (Hitt et al., 1996; Lampe and Spekman, 1997; Draulans et al., 2003). Financial or cost saving motives are - e.g., sharing cost, exploiting financial synergies, outsourcing peripheral activities, or obtaining government subsidies (Dussauge et al., 2000; Colombo, 2003; Cools and Roos, 2005). Our respondents indicated the importance of strategic, technological and financial motives on separate Likert scales between 0 (not important) to 10 (very important).

We assessed the influence of *operational flexibility* because the environment of co-innovation changes rapidly. Flexibility and freedom to explore new technologies plays an increasingly greater role (Buckley and Casson, 1998; Strebel, 2003). As stated before, in innovation, it is impossible to foresee every possible eventuality or challenge. Therefore, operational flexibility in design and execution is required, both from managers and alliance partners, which enables alliance managers to determine the benefits of each partner's organization (Spekman et al., 2000; Strebel, 2003). Following Nooteboom (2000), we separate managerial from organizational flexibility. Our respondents judged their flexibility on a Likert scale between 0 (slow respond to external variation) to 10 (fast respond).

The *strategic stability* of the co-innovation partners is relevant because the strategic priorities may change in time, which in turn may affect the attitude and commitment towards their alliances (Osborn and Baughn, 1990; Hennart et al., 1999). Large companies usually have many different core businesses that compete within the company, resulting in a potential shift of priorities, which might harm the commitment towards specific co-innovation projects. The respondents indicated *strategic stability* on a Likert scale between 0 (hardly ever change of strategic priorities) to 10 (frequent change).

5.7 SCREENING OF THE DATA

Independency of observations is essential in parametric testing. Our observations are to a certain extent correlated, as discussed in Section 5.2, and will be treated accordingly.

First, we conducted a *missing value analysis*. We concluded that 13 cases contain more than 10% of missing values. The respondents in those cases were contacted by telephone in order to complement their scores on the missing values. In addition, we conducted a missing value analysis via SPSS: on average, the data contained 5.7 percent missing values. No single question exceeded the 15% norm for deletion, as formulated by Hair et al. (2010). Two cases were skipped because they contained too many missing values and some cases were excluded from the database because their activities did not meet the scope of our

research criteria.[13] The remaining dataset consists of 157 cases. Patterns could not be found in the remaining missing data, which are missing at random.

Second, we checked the influence of *outliers*. Multiple regression is very sensitive to outliers (Pallant, 2007), which is not uncommon in large datasets. When only a few outliers are found, no further action is considered to be necessary. We undertook further screening where outliers were found by inspection of Cook's distances[14] and critical values of Mahalanobis distances. According to Pallant (2007), cases with a Cook's distance value larger than 1.0 might be a potential problem, because they might have too much overall influence on the model. Critical values for Mahalanobis distance[15] are dependent on the number of independent variables included in an analysis. Our research contains three independent variables (commercial, technological and financial performance). In our research, the critical value of χ^2 is around 14.8 with $p < 0.05$, or 13.3 with $p < 0.01$ (Tabachnick and Fidell, 2007). Field (2007) considers the Mahalanobis distance cut-off point to be dependent on the sample size. In a sample size of N = 100 and 3 independent variables, Mahalanobis values above 15 are considered to be problematic (Field, 2007). We conducted outlier tests in SPSS and Stataand assessed the influence of observations with a large Mahalanobis on our regressions. We examined the cases with a Mahalanobis distance between 15 and 20 further in order to decide whether to retain or to remove them from our analysis. The average Cook's distance of this group is 0.00967 and no systemic outliers could be found,[16] we therefore decided to retain them.

Third, we discuss whether our *sample size* is sufficient, which affects *Type I* (unjustified approval of an hypothesis) and *Type II* errors (unjustified disapproval of an hypothesis). An increase in statistical power is likely to be achieved by increasing the sample size. In order to be able to detect smaller *effect sizes*, larger sample sizes are necessary at the desired α and *power*.[17] The minimum sample size differs from the number of factor loadings: if a factor has four or more loadings greater than 0.40, it is considered to be reliable regardless of the sample size. Factors with fewer low loadings should not be interpreted unless the sample size is greater than 150. According to Hair et al. (2010), with a sample size of 100 and a α-level of 0.01, the power level will be between 0.12

[13] In these cases, the risks are not shared, the cooperation is not aimed entirely at innovation, or the duration of the cooperation is less than two-year.

14 Cook's distance measures the aggregate change in the estimated coefficients when each observation is excluded from the estimation.

15 The Mahalanobis distance gives the squared distance between the group mean together with the associated F tests and p values. It measures the distance of cases from the mean(s) of the predictor variables (Field, 2007).

[16] The maximum individual Cook's distance of a case within this group is 0.079.

[17] α is defined as the probability of making a Type 1 error.

(effect sizes of 0.2) and 0.82 (at moderate effect sizes of 0.5). Sample size affects the possibility of generalization of the results by the ratio of observations to independent variables (Hair et al., 2010): a minimum ratio of observations to independent variables of 5:1 is necessary, with 15 to 20 observations per predictor (Hair et al., 2010). When testing multiple correlation, Tabachnick and Fidell (2007) advise the following formula for minimum sample size: $N \geq 50 + 8\ m$ (where m is the number of independent variables) or $N \geq 104 + m$ for testing individual predictors. The minimum number of cases however, is also dependent on the normality of the dependent variables; when variables are skewed, a larger sample is required. Our sample size of 159 observations, 109 projects and 137 partnerships should be sufficient given our 3 independent variables. In multiple regression, sample size also affects the minimum R^2 that can be detected. With a sample size of 100, an α-level of 0.01 and a p level of 0.80, 10 to 15 % of the variance can be explained (Hair et al., 2010). Too many observations can also affect the results of multiple correlations, we therefore concluded our sample size to be sufficient.

Last, we examined the *normality* of our data, a fundamental assumption in multivariate analysis (Hair et al., 2010). According to Hair et al (2010), non-normality of data can have serious consequences, especially in research with smaller sample sizes - i.e., with less than 50 observations. Testing significance is considered to be less useful with small samples (N < 30) and quite sensitive with large samples (N > 1000). The impact of non-normality diminishes when the sample size reaches 200 or more (Hair et al., 2010). Using a sample size of 157, we checked the normality, kurtosis and skewness of each variable with the use of Q-Q plots and descriptive statistics in SPSS and STATA.[18] Apart from this, our sample size allows for a Shapiro-Wilk (S-W), and a Kolmogorov-Smirnov (K-S) test,[19] which calculates the level of significance of differences in the normal distribution. For the K-S and S-W test, a non-significant result (p <.01) indicates normality. The Q-Q plots show no consistent or systematic deviation from a normal distribution.

Second, we conducted an outlier test using Mahanalobis distance analysis. In order to check outlying cases with regression results outside 3.27 x the standard deviation, no outlying cases are identified with regressions on technological performance and financial performance. For commercial performance however, we found two outlier cases (case nr. 2 and 27), which

[18]In a Q-Q plot, we compare the cumulative distribution of the actual data values to a normal distribution. If the scores are normally distributed, the actual distribution line follows the line of the normal distribution.

19 According to Field (2007), the Shapiro-Wilk test is more accurate.

contained a Mahanalobis distance larger than 20 and therefore had to be examined further in order to detect potential measurement errors; no consistent or systematic error could be detected. We therefore concluded that we did not transgress the normality assumption necessary in multivariate analysis.

5.8 SCALE EVALUATION

In this section, we develop our scales. We evaluate the reliability, internal consistency and validity of our measures. We discuss construct validity, both convergent and discriminant validity, and extract factors with a Principal Component Analysis.

We assessed the *reliability* of our scales - i.e., the absence of random error, as a scale should reflect the construct it is supposed to measure (Hair et al., 2010). In our research, managers were asked to respond only once; we were therefore unable to measure temporal stability when assessing whether repeated measurements lead to the same results (a test-retest). We therefore opted for internal consistency tests as reliability and validity are interrelated (Malhotra and Birks, 2007).

We examined the *internal consistency* of our scales – that is, the degree to which the items that make up the scale are measured within the same construct. *Internal consistency* is linked to the homogeneity or interrelatedness, or the dimensionality of items (Netemeyer et al., 2003). A measure can be uni-dimensional (using items from a single construct or factor) or multi-dimensional (using items from more than one dimension or factor). As explained in Section 5.5, we will conduct Exploratory Factor Analysis (EFA) in order to gain insights into the potential dimensionality of groups of items and scales. The number of factors accounting for the correlations among the variables represents the dimensionality of a set of variables (Netemeyer et al., 2003).

When testing *construct validity*, we investigated the relationship with other constructs, both related and unrelated. We checked the convergent and discriminant validity of our variables. We measured the degree of shared correlation between two measures of the *same* construct (known as convergent validity) and the degree of shared correlation *between* two measures of *different* constructs, the extent to which a latent variable discriminates from other latent variables (discriminant validity). Discriminant validity implies that individual measures should represent *only one* latent construct; we therefore removed individual measures with cross-loadings from further analysis.

We first assessed internal consistency by calculating the Cronbach α values, which is a commonly applied statistic, although according to Hair et al. (2010: 687), Cronbach α may understate convergent validity. The values of Cronbach α are dependent on the number of items on a scale. Pallant (2007) suggests that when a scale consists of less than ten items, Cronbach α values tend to be quite small, and could be substituted by a calculation of the mean inter-item correlation, alternatively, with an increasing number of items, even with the same degree of inter-correlation, the Cronbach α value will increase (Hair et al., 2010). A minimum level of 0.70 or, in the case of exploratory research, 0.60 is recommended for factors consisting of less than ten items. In the case of scales that consist of more than ten items the threshold of Cronbach α should be raised (Hair et al., 2010). Our scales do not contain more than ten items.

Our second assessment of internal consistency was conducted by observing the Eigenvalues (or latent root) of the factors, which represents the amount of total variance explained by a given factor, and expresses the relationship between the scale items. We carried out screetests in which we plotted the Eigenvalues of all factors. Factors above the elbow contributed most to the explanation of the variance in the data set.

Third, we measured convergent and discriminant validity by examining the factor loadings. Latent factors should have a high factor loading. High loadings on a factor indicate high convergent validity, because they have a high proportion of variance in common. At the same time, low cross-loadings make a scale distinctive from other scales: they suggest discriminant validity (Hair et al., 2010).

Fourth, we calculated the average variance extracted (AVE), the average amount of variance in the observed variables that a latent construct is able to explain. AVE is computed as the total of all squared standardized factor loadings divided by the number of items. Whereas the shared variance (or factor loading) relates to the amount of variance in observed variables to *other* constructs (Farell, 2010), the square of a factor loading represents the amount of variation that is explained (or "extracted") by the latent factor. AVE can be considered as a summary indicator of convergence (Fornell and Larcker, 1981).

Hair et al. (2010: 686) mention thresholds, both for factor loadings and for AVE of 0.50. Netemeyer et al. (2003) refers to a maximum loading of ± 0.90. In the case of an AVE of less than 0.5, more error remains in the items than variance explained by the latent factor structure imposed on the measure (Hair et al., 2010: 687). That is, the minimum average factor loading of a scale is 0.71.

Following Hair et al (2010), we tested *discriminant validity* by comparing the AVE with the square of the correlation estimate between the dependent and independent variable. The AVE should be greater than the squared correlation estimate because a latent construct should explain more of the variance in its item measures that it shares with another construct. According to Hair et al (2010: 688), passing this test provides good evidence of discriminant validity.

To summarize: the square root of a bivariate correlation between a dependent and independent variable should not exceed the minimum AVE value of 0.5. That is, apart from potential measurement error, the bivariate correlation should be lower than 0.71. In Tables 5.10, 5.11, and 5.12 all correlations are below this level, which indicates the discriminant validity of our variables. Furthermore, a Principal Component Analysis of all dependent and independent variables show loadings on *different* scales, which in turn show discriminant validity.

Last, we will elaborate on content or nomological validity later by examining the degree that the summated scales result in accurate predictions in Sections 6.3, 6.4 and 6.5. We will discuss the existence of potential measurement errors or common method (CMV) bias in Section 5.9 (CMV in scales) and Section 6.6 (CMV in regressions).

In order to obtain scales for our dependent, independent and control variables, we extracted factors with a *Principal Component Analysis* (PCA). We use the Varimax method of rotation including Kaiser Normalization, which assumes that the underlying factors in the factor analysis are independent or non-correlated. Tabachnick and Fidell (2007:638) state that orthogonal rotation is easier to interpret. A Varimax analysis maximizes the dispersion of factor loadings within factors across variables, which results in more interpretable clusters of factors. In order to assess whether the scales are distinctive and reliable, we conducted the Kaiser-Meyer-Olkin (KMO) test for sampling adequacy, which judges whether the result of the factor analysis is distinctive. A KMO test relates the sum of the partial correlations to the sum of the correlations. KMO values between 0.50 and 0.70 are considered to be acceptable, and above 0.70 just as good.[20] In Tables 5.1, 5.2, 5.3, and 5.4, we extracted our variables with PCA, and suppressed all variables with factor loadings lower than 0.40. In Appendix F, the complete PCA including low factor loadings can be found.

[20] A Bartlett test of sphericity to check whether the variables in a scale are distinctive has not been conducted, because this test is recommended if there are fewer than five cases per variable (Tabachnick and Fidell, 2007). Furthermore, the practical utility is questionable (Field, 2007).

In Table 5.1, we show the PCA of the independent variables that explain 74% of the variance. The KMO measure of sampling adequacy of independent variables is 0.60, which is just acceptable (Tabachnick and Fidell, 2007; Pallant 2007; Field, 2007). In the following, we discuss the factors separately, including the internal consistency, the explained variance and the included questions. In the Principal Component Analyses, the independent variables of our COINN-model appeared on different scales.

We transformed the first factor into a six-item scale, referred to as *trust*, with a Cronbach α of 0.85, consisting of questions concerning disclosure of information by the company and its partner (the questions 5.6a, and 5.6b, see appendix A), meeting the obligations of the partner (question 5.7), the inclination to give responsibility to the partner (question 5.8a), and the willingness and ability to share the expertise of the company and its partner (the questions 5.9a and 5.9b). The inclination of the partner to give responsibility to the focal firm (question 5.8b) was removed because of its cross loading. Similarities of the responding firm and its partner regarding governance structures (question 4.5) were loaded onto this factor, but caused a drop in Cronbach α. We do not include this question separately as a single-item scale, due to the fact that the AVE (0.30) is below the threshold.

The second scale has a Cronbach α of 0.82 and an AVE of 0.59. This scale, referred to as *cultural fit*, contains four questions concerning similarity of communication style (question 5.2), decision-making (question 5.3), leadership (question 5.4), and problem-solving style (question 5.5).

The third factor involves a four-item scale, referred to as *contract need*, has a Cronbach α of 0.81 and an AVE of 0.61. It consists of questions concerning the importance of agreeing upon the contract details in advance (questions 4.7a and 4.7b), and agreement upon a formal contract to commit the partners in the alliance (questions 4.9a and 4.9b).

We converted factor four in a three-item-item scale with a Cronbach α of 0.80 and an AVE of 0.62, referred to as *the ability to transfer of technology*, consisting of questions concerning the transference of knowledge (questions 5.12a and 5.12b) and building and retaining relationships with external partners (question 5.12c).

The fifth factor is a three-item scale, referred to as *partner's embeddedness*, has a Cronbach α of 0.75 and an AVE of 0.60. It consists of questions concerning the partner's role in its other partnerships (question 4.2b), the number of other partnerships (question 4.3b), and the level of experience with co-innovation (question 5.10b).

Factor six shows a three-item scale, referred to as *technical informality*, has a Cronbach α of 0.66 and an AVE of 0.53. It consists of questions regarding the level of informality between the firm and its partner concerning financial issues, R&D issues and project management (questions 4.8c, 4.8d and 4.8e).

The seventh factor loaded onto questions relating to the newness (or uniqueness) of the competences within the firm and its partner (questions 4.10a and 4.10b), and the ease of replacing the firm and its partner (questions 4.12a and 4.12b). Both, the Cronbach α and the AVE of these items are below the thresholds (0.59 and 0.45, respectively) and observed a cross loading of question 4.12b. We therefore only tested question 4.10a ("Partners competences are new") in our analysis, referred to as *partner's competences* and expect a positive relation with performance, see Section 4.3.3.[21]

From factor eight, we could construct a two-item scale with a Cronbach α of 0.79, referred to as *commercial informality*, consisting of questions concerning the level of informality regarding strategic and marketing issues between the firm and its partner (questions 4.8a and 4.8b).

Factor nine involves a two-item scale with a Cronbach α of 0.65, referred to as a *firm's embeddedness*, consisting of questions concerning the firm's number of other partnerships (question 4.3a), and its level of experience with co-innovation (question 5.10a).

From the ninth factor we built a scale with a Cronbach α of 0.74, referred to as *coordination need*, consists of questions regarding the desired level of coordination in the co-innovation venture by the firm and its partner (questions 4.4a and 4.4b).

The items of the eleventh factor could not be used jointly due to insufficient internal consistency and discriminant validity (the Cronbach α is 0.45 and the AVE 0.18), instead, we used the item with the highest factor loading, that is question 4.2a with the AVE of 0.70, referred to as *firm's partnership centrality*.

[21] In Appendices D and E, will we *explore* the joint influence of questions 4.10a and b together with question 4.12a and b, referred to as *balanced competences*.

The items of the twelfth factor suffered from insufficient internal consistency and discriminant validity and were removed from the analysis.

We derived from factor thirteen and fourteen two single-item scales referred to as the *partner's and firm's management involvement* (question 5.11b and 5.11a, resectively).

As can be observed in table 5.2, the PCA of our dependent variables resulted in a four scales that explain 58.9 percent of the variance. The KMO measure of sampling adequacy of the dependent variables is 0.70, which is acceptable (Tabachnick and Fidell, 2007; Pallant 2007; Field, 2007). The dependent variables of our COINN-model loaded in the Principal Component Analyses on different scales.

From the first factor, we constructed a three-item scale referred to as *commercial performance* with a Cronbach α of 0.85 and AVE of 0.65, consisting of questions concerning marketing benefits, the sharing of risk and revenue, the ownership of intellectual property, and cash spending of the alliance (the questions 6.7, 6.8, and 6.9). In the three items, we measured the proportion of the firm vis-à-vis its partner. Because we focus on the interests of the responding firm, we took the reverse values of the scores: high commercial performance indicates that the focal firm generally receives more rights to market the alliances' products, takes a larger proportion of risk, revenue and IP.

The second factor showed high cross loading with question 6.2 and was therefore removed from the analysis. The remaining questions, concerning the contribution of the alliance to the competitive position of the focal firm, the reduction of risk and uncertainty, the break even period and revenue growth of the alliance (the questions 6.1, 6.3, 6.13, and 6.15), showed a Cronbach α of 0.63 and an AVE below the threshold (0.38), indicating that more error can be expected than variance explained by the latent factor structure (Hair et al., 2010: 687). We therefore could not derive a scale from factor two.

Table 5.1: Factor analysis of the independent variables[22]

INDEPENDENT VARIABLES	Rotated Component Matrix														AVE
Firm = Firm; Partner = Partner	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
5.6a Firm openness communication	0.76														
5.6b Partner openness communication	0.85							TRUST							
5.7 Partner meets obligation	0.71														
5.8a We give responsibility	0.42														
5.8b Partner gives responsibility	0.43						0.42								
5.9a Partner shares expertise	0.79														
5.9b Firm shares expertise	0.74														0.53
4.5 Governance structure comparable	0.55														0.30
5.2 Communication style similar		0.71													
5.3 Decision style similar		0.78						CULTURAL FIT							
5.4 Leaderships style similar		0.82													
5.5 Problem solving style similar		0.75													0.59
4.7a Firm: details important			0.80												
4.7b Partner: details important			0.78					CONTRACT NEED							
4.9b Partner: formal contract important			0.78												
4.9a Firm: formal contract important			0.75												0.61
5.12a Technology transfer to extern				0.68											
5.12b Technology transfer from extern				0.81				ABILITY TO TRANSFER TECHNOLOGY							
5.12c Retain relations				0.85											0.62
4.2b Partner's role other partnererships					0.79										
4.3b Partner's nr. Other partnerships					0.80			PARTNER'S EMBEDDEDNESS							
5.10b Partner experience					0.73										0.60
4.8c Financial issues informal						0.72									
4.8d R&D issues informal						0.72		TECHNICAL INFORMALITY							
4.8e Project management issues informal						0.75									0.53
4.10a Partners competence new							0.74								
4.10b Firm's competence new				PARTNER'S COMPETENCES			0.59								0.45
4.12a Partner can replace							0.41								
4.12b Firm can replace							0.45					0.56			
4.8a Strategic issues informal								0.86							
4.8b Marketing issues informal				COMMERCIAL INFORMALITY				0.85							0.73
4.3a Firm's number of other partnererships									0.70						
5.10a Firm's experience				FIRM'S EMBEDDEDNESS					0.77						0.55
4.4a Firm's coordination need										0.82					
4.4b Partner's coordination need				COORDINATION NEED						0.85					0.69
4.2a Firm's role in other partnererships				FIRM'S PARTNERSHIP CENTRALITY							0.84				0.70
4.6 Decision making control											0.44				
5.1b Partner's status											0.43				
4.11 Learning balance												-0.61			0.37
5.11b Partner's management involvement				PARTNER'S MANAGEMENT INVOLVEMENT									0.77		0.60
5.1a Status.firm													0.64		
5.11a Firm's managemennt Involvement				FIRM'S MANAGEMENT INVOLVEMENT										0.84	0.71
Cronbach alpha	0.85	0.82	0.81	0.80	0.75	0.66	0.59	0.79	0.65	0.74	0.45	--	-0.17	--	
Variance explained (%)	13.2	8.7	7.4	6.5	5.9	4.6	4.3	4.2	4.1	3.7	3.1	2.8	2.6	2.5	
Variance explained (cum %)		21.9	29.3	35.8	41.8	46.4	50.6	54.8	58.9	62.6	65.7	68.5	71.2	73.6	
Factor nr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

Note: Extraction Method: Principal Component Analysis, Varimax rotation with Kaiser Normalization converged in 32 iterations.

[22] The item numbers refer to the numbers of the questionnaire (see appendix A).

From the third factor, we derived a two-item scale with a Cronbach α of 0.75 and an AVE of 0.71, referred to as *financial performance*, consisting of and the extent of meeting financial and strategic objectives (the questions 6.16a and 6.16b).

The fourth factor showed shared variance with a Cronbach α of 0.61 of the contribution of the alliance to the innovation position of the focal firm, access to complementary resources, research synergies and the meeting of learning objectives (the questions 6.4, 6.5, 6.6, and 6.16c, respectively). We could not construct a four-item scale due to insufficient AVE (0.44), and therefore selected the question with the highest factor loading (0.74) in the measure of *technological performance*, namely the access to complementary resources, (question 6.5).

Table 5.2: Factor analysis of the dependent variables[23]

DEPENDENT VARIABLES	Rotated Component Matrix				AVE
	1	2	3	4	
6.7 Marketing benefits	0.83				
6.8 Sharing risk/revenue	0.88				
6.9 IP Ownership	0.84	*COMMERCIAL PERFORMANCE*			
6.10 Cash spending	0.65				0.72
6.1 Contribution to competitive position		0.62			
6.2 Possibility to integrate		0.45	0.55		
6.3 Less risk/uncertainty		0.59			
6.13 Break even		0.64			
6.15 Revenue growth		0.67			0.38
6.16a Meeting financial objectives	*FINANCIAL*		0.87		
6.16b Meeting strategic objectives	*PERFORMANCE*		0.81		0.71
6.4 Better innovative position		0.41		0.64	
6.5 Extra complementary resources	*TECHNOLOGICAL PERFORMANCE*			0.74	
6.6 Research synergies				0.60	
6.16c Meeting learning objectives			0.49	0.57	0.44
Cronbach alpha	0.83	0.63	0.75	0.61	
Variance explained (%)	23.9	17.8	9.3	8.0	
Variance explained (cum %)	23.9	41.6	50.9	58.9	
Factor nr.	1	2	3	4	

Note: Principal Component Analysis, Varimax rotation with Kaiser Normalization, converged in 5 iterations.

[23] The item numbers refer to the numbers of the questionnaire (see appendix A).

The Principal Component Analysis of our market control variables resulted in three factors that explain 61.5 percent of the variance. The market control variables of our COINN-model loaded in the Principal Component Analyses on different scales.

From the first factor, we derived a scale with a Cronbach α of 0.77, referred to as *predictability* concerning risk and uncertainty (questions 2.3 and 2.4). An assessment of market complexity (question 2.2) loaded on this factor but reduced the Cronbach α and was therefore removed from the analysis.

The second factor showed loadings on items of knowledge concentration and the technological intensity of the market in which the co-innovation is active. Due to the insufficient internal consistency of these items, we separated this factor into two single-item scales, referred to as *technological intensity* (question 2.5) and knowledge concentration (question 2.8).

The items of the third factor could not be used together; we retained the item with the highest factor loading regarding external turbulence (question 2.7). The results of the PCA of the market control variables are listed in Table 5.3.

Table 5.3: Factor analysis of the market control variables

MARKET CONTROL VARIABLES	Rotated Component Matrix			AVE
	1	2	3	
2.2 Complexity	0.64	*PREDICTABILITY*		
2.3 Risk	0.85			
2.4 Uncertainty	0.86			0.73
2.5 Technical intensity		0.80		0.64
2.8 Knowledge concentration		0.81		0.66
2.1 Ambiguity			0.44	
2.6 Life cycle market			0.64	
2.7 External turbulence			0.81	0.65
Cronbach alpha	0.77	0.54	0.41	
Variance explained (%)	27.4	19.3	14.8	
Variance explained (cum %)	27.4	46.6	61.5	
Factor nr.	1	2	3	

Note: Principal Component Analysis, Varimax rotation with Kaiser normalization converged in 5 iterations.

The Principal Component Analysis of strategic control variables resulted in five factors that explained 75.2 percent of the variance. The strategic control variables of our COINN-model loaded in the Principal Component Analyses on different scales.

We constructed scales from factor 1 and 2 with a Cronbach α of 0.83 and 0.61, respectively, referred to as *partner and firm's operational flexibility*, consisting of questions on organizational and managerial flexibility (questions 3.5b and

3.6b, and questions 3.5a and 3.6a, respectively). In addition to this, we made a single-item scale referred to as strategic partner motives (question 3.1b).[24]

We translated the third factor into a scale with a Cronbach α of 0.66, referred to as *strategic stability*, consisting of the frequency of the change of strategic priorities of the firm and its partner in general (questions 3.7a and 3.7b). We divided the fourth factor, due to insufficient internal consistency, into three single-item scales: a *firm's cost motives*[25] (question 3.3a), *partner cost motives* (question 3.3b) and *a firm's strategic motives* (question 3.1a). Last, from factor five, we constructed a scale, referred to as *technological motives*, containing questions concerning the increase of R&D output, and organizational learning (questions 3.2a and 3.2b). The results of the PCA of the strategy control variables are listed in Table 5.4.

Table 5.4: Factor analysis of the strategic control variables[26]

STRATEGIC CONTROL VARIABLES	Rotated Component Matrix					AVE
F. = Firm; P. = Partner	1	2	3	4	5	
3.4 Strategic match	0.63					
3.5b Partner's organizational flexibility	0.81		*PARTNER'S FLEXBILITY*			
3.6b Partner's managerial flexibility	0.87					0.70
3.5a Firm's organizational flexibility		0.83	*FIRM'S OPERATIONAL FLEXIBILITY*			
3.6a Firm's managerial flexibility		0.78				0.65
3.1a Firm's strategic motives			0.58			
3.1b Partner's strategic motives	0.43				0.49	
3.2a Firm's technological motives		0.40	*TECHNOLOGICAL MOTIVES*		0.70	
3.2b Partner's technological motives					0.73	0.51
3.3a Firm's financial motives	*COST MOTIVES*		0.85			
3.3b Partner's financial motives			0.62			0.73
3.7a Firm's change in strategic priorities	*STRATEGIC STABILITY*			0.78		
3.7b Partner's change in strategic priorities				0.81		0.64
Cronbach alpha	0.84	0.61	0.63	0.64	0.5	
Variance explained (%)	17.2	16.1	12.2	9.5	7.4	
Variance explained (cum %)	17.2	33.3	45.5	55.0	62.3	
Factor nr.	1	2	3	4	5	

Note: Principal Component Analysis, Varimax rotation with Kaiser Normalization converged in 9 iterations.

[24] Question 3.4 (strategic match) was removed from further analysis due to insufficient internal consistency with question 3.1b (see appendix A) and a relatively low factor loading.
[25] Defined in a narrow sense: by sharing development costs, saving cost, obtaining subsidies, and exploiting financial synergies.
[26] The item numbers refer to the numbers of the questionnaire (see appendix A).

Based on our subsample 2a (see Section 5.2) of single observations together with the average scores of multiple-respondent partnerships, in Tables 5.5 and 5.6, we list the descriptive statistics of the dependent and independent variables, followed by the descriptive statistics of the interval, ordinal and nominal control variables in Tables 5.7, 5.8, and 5.9.[27] In addition, we show the correlations of the dependent, independent, and control variables with performance in Tables 5.10, 5.11, and 5.12, respectively.

Table 5.5: Descriptive statistics of the dependent variables

Variable	N	Mean	Sd	Min	Max
Commercial performance	137	6.0	2.5	0.0	10.0
Financial performance	137	5.7	2.5	0.0	9.9
Technological performance	134	6.9	2.9	0.0	10.0

Table 5.6: Descriptive statistics of the independent variables

	Variable	N	Mean	Sd	Min	Max
1	Contract need	137	6.5	2.4	0.0	10.0
2	Firm's embeddedness	137	6.7	2.2	0.0	10.0
3	Firm's centrality	136	7.4	2.0	0.1	10.0
4	Partner's embeddedness	137	5.8	2.3	0.0	9.7
5	Partner's competences	135	7.2	2.7	0.0	10.0
6	Coordination need	137	6.7	2.4	0.0	10.0
7	Trust	137	7.3	1.8	0.0	10.0
8	Cultural fit	137	5.0	2.4	0.0	9.0
9	Technology transfer	137	7.2	1.9	0.0	10.0
10	Firm's management involvement	137	7.4	2.7	0.0	10.0
11	Partner's management involvement	137	6.9	2.8	0.0	10.0
12	Technical informality	137	4.8	2.4	0.0	9.8
13	Commercial informality	137	5.1	2.9	0.0	10.0

[27] The scores are aggregated at the partnership level from the average multiple observations database (sample 2a, see Section 5.2).

Table 5.7: Descriptive statistics of the interval control variables

Variable	N	Mean	Sd	Min	Max
Alliance characteristics					
Project life	137	4.7	3.2	0.0	10.0
Partner's innovativeness	137	6.2	2.7	0.0	10.0
Firm's importance	137	7.0	2.5	0.0	10.0
Partner importance	137	6.5	2.6	0.0	10.0
Initial conditions	137	6.7	2.7	0.0	10.0
Market characteristics					
Market predictability	137	5.7	2.6	0.0	10.0
Technical intensity	133	7.8	2.3	0.0	10.0
Knowledge concentration	134	6.7	2.6	0.7	10.0
External turbulence	134	5.2	2.5	0.9	10.0
Strategy characteristics					
Partner's operational flexibility	137	5.8	2.7	0.0	10.0
Firm's operational flexibility	137	6.5	2.4	0.0	10.0
Firm's strategic motives	134	7.9	2.0	0.9	10.0
Technological motives	137	6.7	2.2	0.0	10.0
Cost motives	137	5.9	2.5	0.0	10.0
Strategic stability	137	3.8	2.2	0.0	9.1

Table 5.8: Descriptive statistics of the ordinal control variables

Variable	N	Mean	Min	Max
Alliance characteristics, ordinal scales				
Number of partners	137	3.3	1.0	9.0
Firm's size (000 €)	137	989.6	0.7	3,750.0
Partner's size (000 €)	137	787.2	0.7	3,750.0
Firm's size (employees)	137	5,737.6	13.0	37,500.0
Partner's size (employees)	137	4,520.9	13.0	37,500.0
Sales difference (firm/partner)	137	1,663.4	0.0	55,970.2
Employment difference (firm/partner)	137	129.4	0.0	2,884.6
Firm's sales per employee (000 €)	137	0.7	0.0	10.6
Partner's sales per employee (000 €)	137	0.6	0.0	10.0
Firm's new products	137	11.3	0.0	23.0
Project duration (years)	137	11.3	1.0	28.0

Table 5.9: Descriptive statistics of the nominal control variables

Alliance characteristics, nominal scales, *N= 137, Min. = 0, Max. = 1*
▪ Industry dummies: food / manufacturing / service industry
▪ Role: project managers role / strategic managers role / mixed role
▪ Firm's nationality: Netherlands / other
▪ Partner nationality: Netherlands or Belgium / other
▪ Firm's input: commercial / technical / financial / multiple input
▪ Partner input: commercial / technical / financial / multiple input

Table 5.10: Correlations of the dependent variables

		PC	**PF**	**PT**
PC	*Commercial performance*			
PF	*Financial performance*	-0.09*		
PT	*Technical performance*	0.07*	0.18*	
1	*Contract need*	-0.08*	0.07*	-0.11*
2	*Firm's embeddedness*	-0.39*	0.13*	0.05
3	*Firm's centrality*	-0.15*	0.25*	-0.01
4	*Partner's embeddedness*	-0.05	0.22*	0.06
5	*Partner's competences*	0.07*	0.06*	0.18*
6	*Coordination need*	-0.22*	-0.04	0.01
7	*Trust*	-0.10*	0.16*	0.15*
8	*Cultural fit*	0.03	0.18*	0.00
9	*Technology transfer*	-0.22*	0.44*	0.22*
10	*Firm's management involvement*	-0.06*	-0.02	0.23*
11	*Partner's management involvement*	-0.11*	-0.04	0.02
12	*Technical informality*	-0.08*	0.08*	0.10*
13	*Commercial informality*	-0.10*	0.14*	0.15*
		PC	**PF**	**PT**
1	*Market predictability*	-0.10*	-0.04	0.00
2	*Technical intensity*	0.11*	0.03	-0.01
3	*Knowledge concentration*	-0.04	0.23*	0.00
4	*External turbulence*	-0.17*	-0.12*	-0.01
5	*Partner's operational flexibility*	-0.16*	0.17*	0.14*
6	*Firm's operational flexibility*	-0.28*	0.22*	0.00
7	*Technological motives*	-0.21*	0.14*	0.30*
8	*Cost motives*	-0.10*	-0.11*	0.02
9	*Strategic stability*	-0.14*	0.16*	0.04
10	*Project life cycle*	-0.14*	0.06*	-0.25*
11	*Partner's innovativeness*	0.10*	0.04	0.16*
12	*Partner's importance*	-0.28*	0.11*	0.22*
13	*Initial conditions*	0.06*	0.17*	0.19*
14	*Firm's strategic motives*	0.04	0.05	0.13*

*Note: * $p < 0.05$.*

Table 5.11: Correlations of the independent variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. *Contract need*												
2. *Firm's embeddedness*	0.11*											
3. *Firm's centrality*	-0.03	0.27*										
4. *Partner's embeddedness*	0.13*	0.02	-0.04									
5. *Partner's competences*	-0.07*	-0.14*	0.09*	0.02								
6. *Coordination need*	0.17*	0.19*	0.08*	0.08*	0.16*							
7. *Trust*	0.13*	0.12*	0.06*	0.16*	0.10*	0.12*						
8. *Cultural fit*	-0.01	-0.10*	0.02	0.30*	-0.06*	0.08*	0.32*					
9. *Technology transfer*	0.23*	0.30*	0.08*	0.24*	0.16*	0.19*	0.36*	0.12*				
10. *Firm's management involvement*	0.13*	0.02	-0.07*	0.01	0.08*	0.17*	0.24*	0.13*	0.19*			
11. *Partner's management involvement*	0.19*	0.04	0.01	-0.04	0.10*	0.13*	0.22*	-0.01	0.17*	0.32*		
12. *Technical informality*	-0.07*	0.00	0.10*	0.09*	0.08*	0.02	0.08*	0.19*	0.01	-0.08*	0.00	
13. *Commercial informality*	-0.06*	0.13*	-0.01	-0.11*	0.06*	-0.08*	0.14*	-0.05	-0.02	-0.02	-0.07*	0.08*

*Note: * $p < 0.05$.*

Table 5.12: Correlations of the control variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. *Market predictability*													
2. *Technical intensity*	0.11*												
3. *Knowledge concentration*	-0.02	0.38*											
4. *External turbulence*	-0.03	0.01	-0.01										
5. *Partner's operational flexibility*	0.06*	0.01	0.01	0.10*									
6. *Firm's operational flexibility*	0.29*	0.07*	0.20*	-0.20*	0.17*								
7. *Technological motives*	0.31*	-0.06*	-0.03	-0.03	0.28*	0.35*							
8. *Cost motives*	0.27*	0.36*	0.02	0.19*	0.06*	0.18*	0.33*						
9. *Strategic stability*	0.03	-0.22*	-0.15*	0.13*	0.22*	-0.03	0.01	-0.01					
10. *Project life cycle*	-0.04	-0.18*	-0.09*	0.04	-0.16*	0.21*	-0.04	0.05	0.16*				
11. *Partner's innovativeness*	-0.05	0.07*	-0.08*	-0.14*	-0.11*	0.11*	0.18*	0.10*	-0.03	-0.01			
12. *Partner's importance*	-0.01	0.13*	-0.01	0.18*	0.45*	-0.09*	0.16*	0.23*	0.18*	-0.01	-0.15*		
13. *Initial conditions*	-0.02	0.03	0.12*	-0.05	0.15*	0.14*	0.05	-0.13*	-0.11*	-0.26*	0.08*	0.03	
14. *Firm's strategic motives*	0.20*	0.15*	-0.03	0.02	-0.01	0.17*	0.20*	0.25*	-0.18*	-0.05	0.20*	-0.04	0.07*

*Note: * $p < 0.05$.*

Before testing the hypotheses, we evaluated our COINN scales in order to verify whether the main assumptions of OLS regressions are met (Pevalin and Robson, 2009: 288-303). We assessed the normality of errors (homoscedasticity) and checked whether the variance of errors is constant by observing scatterplots of predicted values against residuals. A lack of linearity in residuals would not invalidate our analysis, but would weaken it (Tabachnick and Fidell, 2007). The Residuals-versus-Fitted (Rvf) plot of our scales is evenly distributed across the values of our independent variables. We found no distinctive pattern in the residuals, and therefore concluded that they are evenly distributed.[28] Furthermore, a skewness-kurtosis test did not reject the null hypotheses of normality on any of our scales. [29]

5.9 SUMMARY AND CONCLUSIONS

Given the scope of our research objectives, we have chosen to collect primary data in a quantitative research approach. Our data have a mixed hierarchical and non-hierarchical structure. This partly multi-level, partly cross-classified, nested or correlated structure has an influence on the appropriate statistical treatment: we decided to deal with our data by partially aggregating our database and by constructing subsample datasets.

We based our conceptual research model on four theoretical perspectives, designed and tested a questionnaire, which served as a guideline for interviews. We discussed our data collection, and screened our data on missing values, outliers, sample size and normality.

In Chapter 6, we will discuss potential multicollinearity, the robustness of our regressions, potential misspecification of our model, and potential excessive leverage or influence of single observations.

With the use of exploratory factor analysis, we constructed our definitive model, which we test in the next chapter. This model consists of dependent variables (commercial, technological and financial performance), control variables, and independent variables. In Figure 5.6, we summarize the definitive hypotheses after PCA, and in Figure 5.7 our definitive COINN-model.

In our definitive analysis, we separate '*embeddedness*' into separate scales, referred to as *'firm's embededdness'*, *'firm's centrality'*, and *'partner's embededdness'*. We

[28] The Rvf-plots are available upon request.
[29] Through the SK-test in Stata. A Shapiro-Francia test confirms this conclusion. This test shows that our scales can be considered to be normally distributed, mostly at the 0.01 significance level, except our scale commercial informality, which is significant at $p < 0.05$.

limit '*balanced competences*' to a scale, referred to as '*partner's competences*'. Furthermore, we separate '*management involvement*' into separate scales for the firm and its partner, and the scale '*informality*' into '*commercial and technical informality*'. The changes are underlined in Figure 5.6.

Figure 5.6: Summary of definitive hypotheses (after PCA)

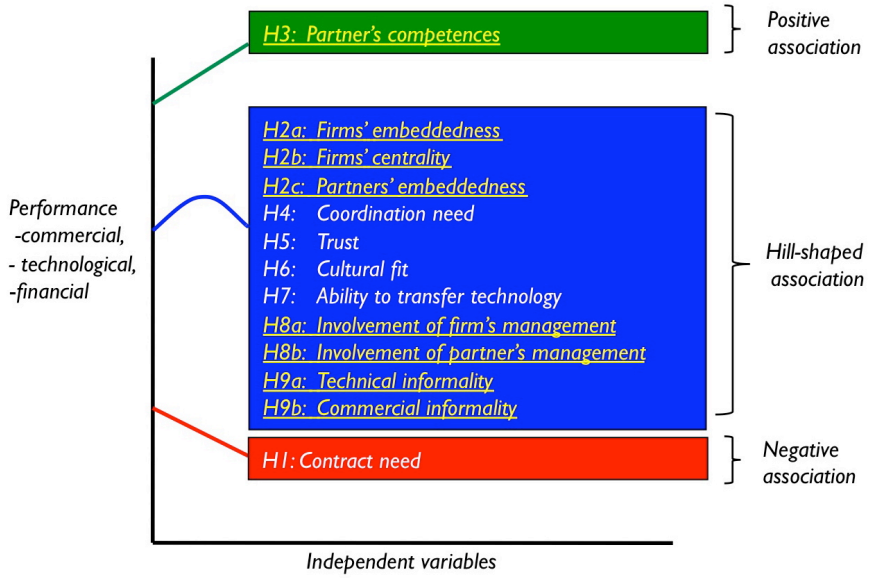
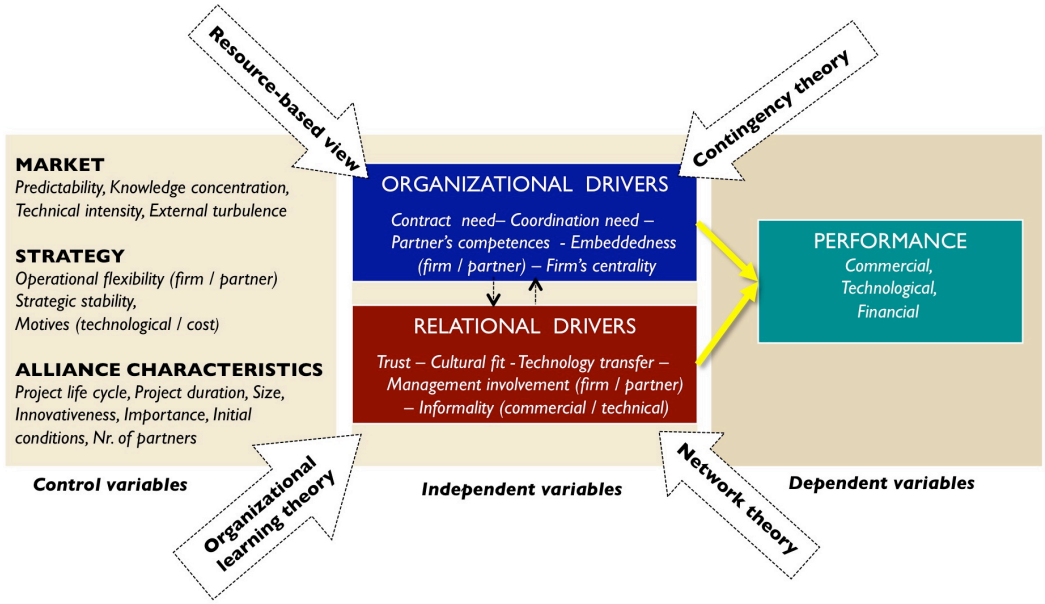


Figure 5.7: Definitive COINN-model



As indicated in Section 5.8 (scale evaluation), we discuss the existence of potential measurement errors in our scales.

We based the dependent and the independent variables as well as most of the control variables in our COINN-model on perceptions of the same respondents, which may cause distortion because of a common method bias (CMV). In order to reduce potentially CMV errors, we took several procedural remedies and conducted statistical checks (see Section 5.3). In Section 5.8, we based our scales on generally accepted norms of convergent and discriminant validity. We therefore conclude that in our scales, a CMV bias is rather unlikely.

6. RESULTS

6.1 INTRODUCTION

In this chapter, we regress the COINN-model, which consists of the scales of our independent organization and relationships variables, dependent variables (performance), as well as control variables. In different regression models, we test our hypotheses and discuss the results.

6.2 MULTIVARIATE REGRESSION MODELS

In order to test the influence of the independent variables on the predictor variables, we construct five multivariate regression models, as shown in Figure 6.1 and Table 6.1. Each model adds new terms to the significant variables of the previous model.[1] In Model 1, we examine the influence of the control variables on performance; in Model 2, we add the organizational variables. In Model 3, we study potential curvilinear effects of these organizational variables, and in Model 4, we add the relational variables to the model, followed by Model 5 (curvilinear effects of relational variables). We show the significant regression results of these models in Table 6.2 (regression on *commercial performance*)[2], Table 6.3 (*technological performance*), and Table 6.4 (*financial performance*). The non-significant regression estimates are suppressed for practical reasons. The full regression tables are shown in Appendix F. We test the significance of the contribution of each model with a Wald test. In the model of *commercial performance,* all effects together explain 45.5 % (R^2) or 29.3% (adjusted R^2) of the total variance. When explaining the second dependent variable (*technological performance*), all effects jointly explain 42.2 % (R^2) or 25.0 % (adjusted R^2) of the total variance. For the third dependent variable (*financial performance*), this is 59.5 % (R^2) or 43.2 % (adjusted R^2) of the total variance.

In Section 5.7, we derived six organizational and seven relationship scales. We summarize the regression results of these scales in the Tables 6.5, 6.6, and 6.7,[3] and subsequently discuss the results per indicator.

[1] These models are based on the average subsample 2a as described in Section 5.2.
[2] The constructs is italic refer to the dependent and independent variables as defined in Section 5.9.
[3] In Tables A.1, A.7, and A.8 of Appendix D, we explore the regressions of the scales with industry and project maturity.

Figure 6.1: COINN regression models

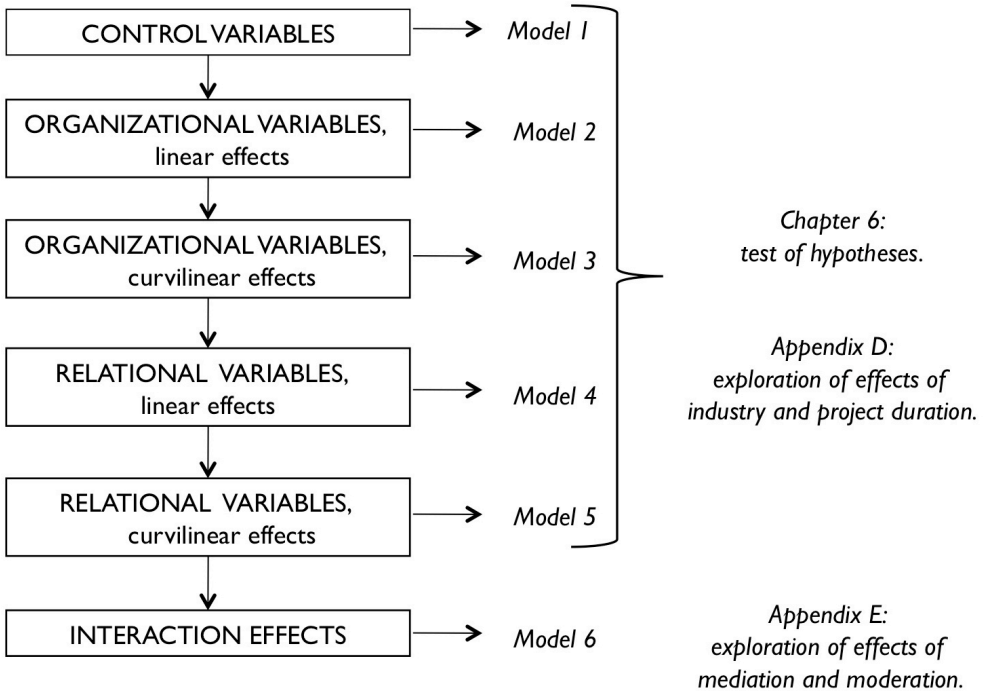


Table 6.1: COINN regression models

Model 1	$P \sum_i = \beta_i CONTR$
Model 2	$P \sum_i = Model\ 1^* + \beta \sum_j OR_j$
Model 3	$P \sum_i = Model\ 2^* + \beta_j \sum_j (OR_j)^2$
Model 4	$P \sum_i = Model\ 3^* + \beta_k \sum_k RE_k$
Model 5	$P \sum_i = Model\ 4^* + \beta_k \sum_k (RE)_k^2$
Model 6	$P \sum_i = Model\ 5^* + \beta_k \sum_k (mediation)_k$
Where	
P, OR, RE, CONTR	*CONTR = Control variables ($C_1 \ldots C_{10}$), P = Performance, OR = Organizational variables ($OR_1 \ldots OR$, RE= Relational Variables ($RE_1 \ldots RE_5$)* [4]
β =	*Regression coefficients, i = 1…10, j = 1…8, k = 1 … 5*

We discuss first potential multicollinearity, the robustness of our regressions, and potential misspecification within our model.

[4] Consisting of the scales with variables as defined in Section 5.8.

Multicollinearity may distort the results of our regressions or even make them unstable, which would imply that they cannot serve as a basis for general conclusions (Hair et al., 2010). We observed the bivariate correlation values, the value of which should be limited: Tabachnick and Fidell (2007) recommend a threshold of 0.5.[5] Consulting the correlation matrices in Chapter 5, revealed that multicollinearity is not an issue.

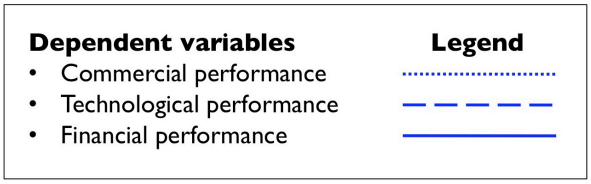
We calculated the *Variance Inflation Factor (VIF)*, indicating the relationship between the scales via robust linear regression, taking into account the level of correlation in the data. The average VIF of our scales is 1.17 for all three predictors (values between 1.06 and 1.32), which is far below the critical value of 10 as suggested by Tabachnick and Fidell (2007), Pallant (2007) and Hair et al. (2010). We therefore conclude that multicollinearity is not a concern.

In order to assess the *robustness* of our regressions, we checked the differences of the regression results using the different datasets 2a-2d, as discussed in Section 5.2 (research design).[6] All regressions are robust - i.e., significant in most models - unless otherwise stated. We discuss the significant associations per variable hereafter.

We tested whether our models contain *omitted variables*, with the use of the Ovtest in STATA. In Model 5 of all three types of performance (commercial, technological, as well as financial), the hypothesis of omitted variables were not significant at $p < 0.01$. We could not detect misspecification.

We visualize the significant associations in standardized graphs, in which we plot the dependent variables on Y-axes, and the independent variables on X-axes, following the legend in Figure 6.2.

Figure 6.2: Legend of performance figures



[5] Graham (2009) mentions that bivariate correlation should be lower than 0.7.
[6] The samples contain the same single observations, aggregated at the partnership level, but vary as to multiple observations. In subsample 2a, we took the *average* scores of the partnerships from which we obtained several observations, in subsample 2b the *maximum* score, in subsample 2c the *minimum* score, and in subsample 2d the *difference between the maximum and minimum* of the score of the partnerships.

Table 6.2: Multivariate regressions with commercial performance

		COMMERCIAL PERFORMANCE				
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	NR.OF PARTNERS	1.71*	1.33*	1.32°	1.35°	1.31
		(2.61)	(2.03)	(1.98)	(1.93)	(1.63)
	NR.OF PARTNERS	-0.20**	-0.16*	-0.15*	-0.16*	-0.15°
	(Quadratic)	(-3.28)	(-2.48)	(-2.29)	(-2.22)	(-1.91)
		-0.24**	-0.22*	-0.22*	-0.20°	-0.22°
		(-2.80)	(-2.55)	(-2.61)	(-1.86)	(-1.67)
	PARTNER'S STRATEGIC MOTIVES	-0.19*	-0.21*	-0.19*	-0.20°	-0.19
		(-2.29)	(-2.19)	(-2.23)	(-1.89)	(-1.26)
	FIRM'S FLEXIBILITY	-0.38***	-0.31***	-0.30***	-0.30**	-0.32**
		(-4.29)	(-4.45)	(-3.88)	(-3.20)	(-2.95)
Organizational variables	FIRM'S EMBEDDEDNESS		-0.24°	-0.08	-0.05	0.01
			(-1.76)	(-0.11)	(-0.06)	(0.01)
	PARTNER'S COMPETENCES		0.05	-0.67°	-0.63	-0.65
			(0.75)	(-1.86)	(-1.60)	(-1.46)
	PARTNER'S COMPETENCES			0.061*	0.06°	0.06°
	(Quadratic)			(2.05)	(1.88)	(1.68)
	_cons	9.153***	11.32***	10.73**	10.80**	11.36*
		(7.08)	(6.18)	(3.06)	(2.74)	(2.14)
	N	134	132	132	132	132
	R-sq	29.0%	36.2%	39.7%	40.3%	41.5%
	adj. R-sq	25.1%	29.1%	29.5%	25.6%	21.7%
	F	15.02	1.63	1.00	0.30	0.39
	P > F	0.00	0.16	0.44	0.95	0.34

Notes: t statistics in parentheses, ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

F-test: significance compared with the previous model.

Table 6.3: Multivariate regressions with technological performance

TECHNOLOGICAL PERFORMANCE						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	FIRM'S MULTI INPUT	1.15***	1.00**	1.13**	1.12**	0.85
		(3.59)	(2.74)	(2.72)	(2.71)	(1.89)
	FIRM'S INNOVATIVENESS	-0.01	-0.02	-0.04	-0.07	-0.09°
		(-0.21)	(-0.49)	(-0.90)	(-1.59)	(-1.83)
	PARTNER'S IMPORTANCE	0.25*	0.26*	0.29*	0.34**	0.25°
		(2.33)	(2.47)	(2.67)	(3.04)	(2.00)
	TECHNOLOGICAL MOTIVES	0.42***	0.36**	0.34*	0.25°	0.27°
		(3.53)	(2.78)	(2.45)	(1.80)	(1.70)
Organizational variables	CONTRACT NEED		-0.29*	0.24	0.26	0.29
			(-2.31)	(0.44)	(0.45)	(0.51)
	COORDINATION NEED		-0.03	-1.29*	-1.32*	-1.61**
			(-0.28)	(-2.59)	(-2.66)	(-2.94)
	COORDINATION NEED (Quadratic)			0.11*	0.11*	0.14**
				(2.42)	(2.55)	(2.91)
Relational variables	TRUST				-0.05	-2.49°
					(-0.28)	(-1.72)
	TRUST (Quadratic)					0.19°
						(1.72)
	TECHNOLOGY TRANSFER				0.25	1.59°
					(1.50)	(1.69)
	FIRM'S MANAGEMENT INVOLVEMEMENT				0.25°	0.49
					(1.78)	(0.91)
	PARTNER'S MANAGEMENT INVOLVEMENT				-0.22°	-0.57
					(-1.87)	(-1.19)
	_cons	0.03	1.85	2.65	1.80	7.31
		(0.02)	(1.17)	(1.04)	(0.53)	(1.42)
	N	134	132	132	132	132
	R-sq	21.0%	25.7%	30.2%	37.6%	42.2%
	adj. R-sq	18.6%	19.5%	20.4%	24.3%	25.0%
	F	9.49	1.14	1.14	1.31	1.11
	P > F	0.00	0.36	0.35	0.27	0.37

Notes: t statistics in parentheses, ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

F-test: significance compared with the previous model.

Table 6.4: Multivariate regressions with financial performance

		FINANCIAL PERFORMANCE				
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	PROJECT DURATION	0.25°	0.36*	0.30*	0.20	0.22
		(1.94)	(2.44)	(2.07)	(1.10)	(1.17)
	PROJECT DURATION (Quadratic)	-0.01*	-0.02**	-0.01*	-0.01	-0.01
		(-2.60)	(-3.16)	(-2.53)	(-1.26)	(-1.36)
	LIFE CYCLE PHASE	0.79*	0.86**	0.94**	0.61°	0.67°
		(2.69)	(2.88)	(3.11)	(1.83)	(1.80)
	LIFE CYCLE PHASE (Quadratic)	-0.07*	-0.08**	-0.09**	-0.05°	-0.06°
		(-2.68)	(-2.90)	(-3.17)	(-1.68)	(-1.75)
	PARTNER'S NATIONALITY	0.98°	0.82°	1.03*	1.04°	1.08°
		(1.83)	(1.67)	(2.27)	(1.89)	(1.93)
	FIRM'S SALES P. EMPLOYEE	0.72***	0.66***	0.71**	0.59**	0.68**
		(3.87)	(3.91)	(3.32)	(2.92)	(3.23)
	FIRM'S INNOVATIVENESS	0.11***	0.11**	0.11**	0.11***	0.11***
		(4.01)	(3.46)	(3.46)	(3.82)	(3.57)
	KNOWLEDGE CONCENTRATION	0.17°	0.12	0.15°	0.19*	0.18°
		(1.77)	(1.34)	(1.73)	(2.37)	(1.99)
Organizational variables	CONTRACT NEED		-0.11	-1.29***	-1.51***	-1.39***
			(-1.20)	(-3.53)	(-4.72)	(-3.90)
	CONTRACT NEED (Quadratic)			0.096**	0.12***	0.11**
				(2.86)	(3.93)	(3.27)
	FIRM'S CENTRALITY		0.13	1.11***	1.30***	1.22***
			(1.07)	(3.71)	(4.75)	(4.29)
	FIRM'S CENTRALITY (Quadratic)			-0.08**	-0.10***	-0.10***
				(-3.16)	(-4.06)	(-3.83)
	PARTNER'S EMBEDDEDNESS		0.20°	-0.13	-0.30	-0.23
			(1.78)	(-0.32)	(-0.93)	(-0.71)
Relational variables	CULTURE FIT				0.18°	0.28
					(1.72)	(0.80)
	TECHNOLOGY TRANSFER				0.34*	0.17
					(2.30)	(0.41)
	COMMERCIAL INFORMALITY				0.15*	-0.15
					(2.16)	(-0.46)
	_cons	-0.19	-1.86	2.40	-0.55	-1.05
		(-0.15)	(-1.07)	(0.88)	(-0.21)	(-0.27)
	N	132	130	130	130	130
	R-sq	35.1%	41.3%	49.5%	58.1%	59.5%
	adj. R-sq	29.1%	32.4%	38.6%	45.4%	43.2%
	F	7.5	2.17	2.87	2.18	0.52
	P > F	0.00	0.06	0.02	0.05	0.81

Notes: t statistics in parentheses, ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

F-test: significance compared with the previous model.

6.3 RESULTS OF THE ORGANIZATIONAL DRIVERS

The regressions with *commercial performance* are shown in Table 6.2 (only the significant regressions) and in Appendix F, Table F.4 (all regressions). The linear and quadratic terms of the organizational variables (Model 2) do not significantly contribute to the explained variance. When explaining the second dependent variable (*technological performance*, see Table 6.3 or Table F.5), the linear and quadratic terms of the organizational variables do not contribute significantly to the R^2 or the adjusted R^2. For the third dependent variable (*financial performance*, see Table 6.4 or Table F.6), the linear terms of the organizational variables contribute to the explained variance, with 6.2 % (R^2) or 3.3 % (adjusted R^2) at a significance level of $p < 0.1$., while the quadratic terms of the organizational variables add 8.6 % the R^2 or 16.8 % to the adjusted R^2, significant at $p < 0.05$.

Table 6.5: Regression results of organizational drivers

	Commercial performance	***Technological performance***	***Financial performance***
Contract need	NS	Negative (M2)*	U-shaped**/***
Firm's embeddedness	Negative (M2)°	NS	NS
Firm's centrality	NS	NS	Hill-shaped**/***
Partner's embeddedness	NS	NS	Positive (M2)°
Partner's competences	U-shaped°/*	NS	NS
Coordination need	NS	U-shaped*	NS

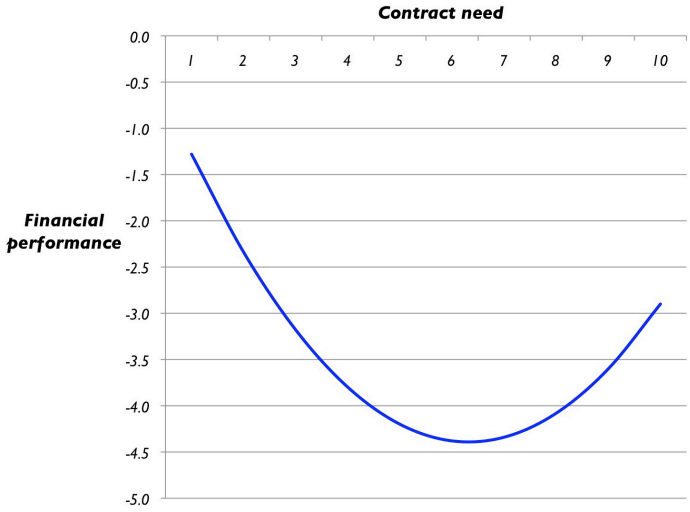
Notes: NS = non significant; U-shaped = negative linear, positive quadratic effect, Hill-shaped = positive linear, negative quadratic effect. Positive, negative = positive, negative linear effect, respectively, ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001, M2 = significant in Model 2.*

In **hypothesis 1**, we predicted that *contract need*, defined as a strong tendency to agree upon details and a formal contract in advance, is negatively associated with performance. This hypothesis is supported in the case of *financial performance*, where the linear term is highly significant at $p < 0.001$ and the quadratic term at $p < 0.01$, resulting in a curvilinear U-shaped effect on *financial performance*, see Figure 6.3. As far as *technological performance* is concerned, we observed the expected negative association only in Model 2.

With *financial performance*, the optimum *contract need* is at a minimal level. Increasing values of *contract need* cause deterioration in *financial performance*, although above an inflection point of 6.3, where the curvilinear effect exceeds the linear effect, the negative effect is reduced.

The need to agree upon detail and a formal contract in advance has a negative impact on *financial performance* because it involves extra governance costs and reduces flexibility, which is necessary for the innovation process. However, a strong *contract need* reduces to a certain extent the negative effect due to stricter cost control, resulting in potential cost savings. Contract need does not correlate significantly with *commercial or technological performance*.

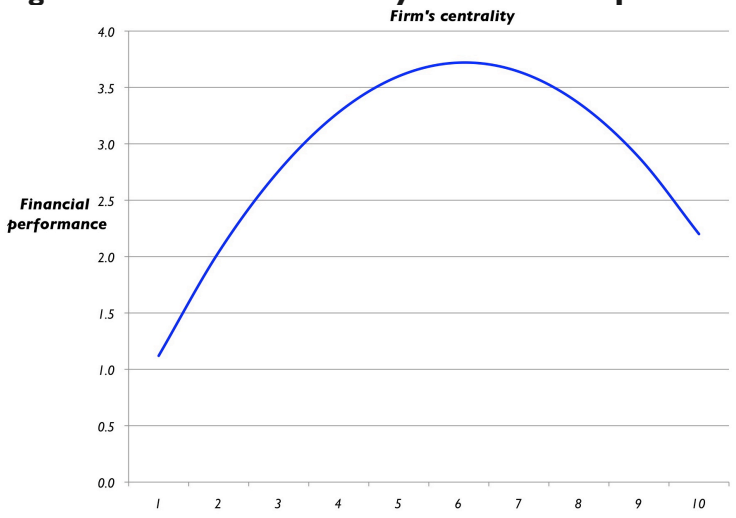
Figure 6.3: Contract need and financial performance



In **hypothesis 2a and 2b**, we predicted hill-shaped associations with performance of a *embeddedness*. In Section 5.8, we divided embeddedness into three scales, *firm's* and its *partner's embeddedness, and firm's centrality in its network.* We predicted that a combination of network experience, the number of partnerships and the centrality in a network, to be beneficial to a certain extent. At the same time, over-embeddedness might be counter-productive. The expected hill-shaped relation is found in the regressions with *firm's centrality* with *financial performance*, where above a substantial level (i.e. 6.7), the curvilinear exceeds the linear effect (see Figure 6.4). When firms play a central role in its networks, they are usually able to meet a larger proportion of their strategic and financial objectives. We could not find support for hypothesis 2a on *firm's embeddedness* and hypothesis 2b on *partner's embeddedness*. We observed a negative effect in Model 2 in the regressions with commercial performance of firm embeddednes and a

positive effect in Model 2 in the regressions with financial performance of partner's embeddedness.

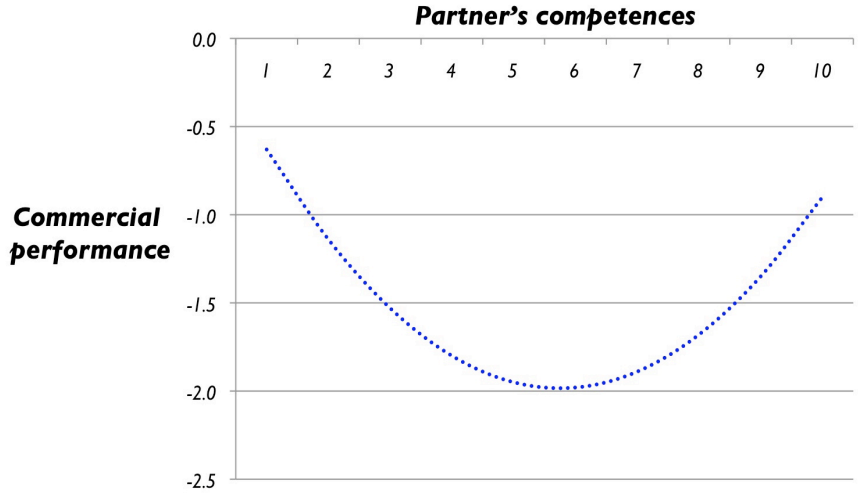
Figure 6.4: Firm's centrality and financial performance



In **hypothesis 3**, we predicted a positive association between *balanced competences* and performance. We defined *balanced competences* as a combination of a high degree of newness (or uniqueness) of the competences of the firm and its partner, and difficulty in replacing both the firm and its partner. In Section 5.9, we decided to limit our test to '*partner's competences*' only. We observed a U-shaped association of '*partner's competences*' with *commercial performance* with an inflection point of 5.8 (see Figure 6.5). We could not find a significant association in general with *technological or financial performance*. We conclude that we only could test hypothesis 3 as far as *partner's competences* is concerned and find proof in the regressions with *commercial performance*.

If a *partner's competences* are unique, the firm can expect a lower proportion of marketing benefits, ownership of Intellectual Property, and revenues (or losses).

Figure 6.5: Partner's competences and commercial performance



Hypothesis 4a regarding similarity of governance structures could not be tested (see Section 5.9).

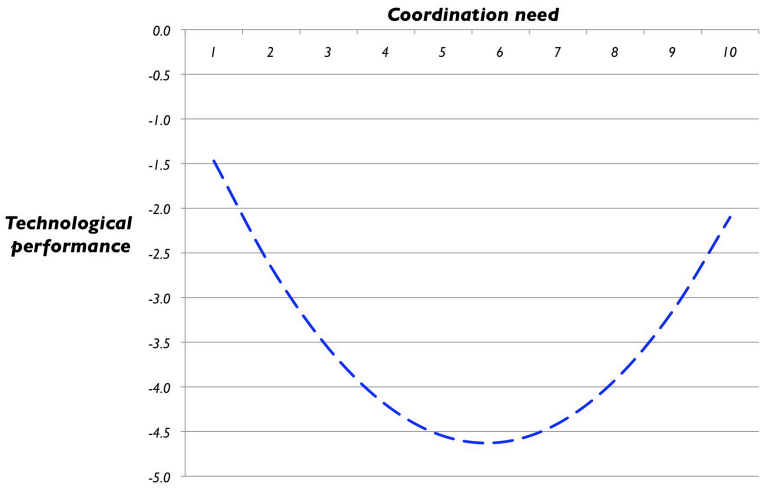
In **hypothesis 4b**, we predicted *coordination need* of the alliance partners to have a hill-shaped association with the performance; we expected that some coordination would improve the results, while too much coordination might lead to a loss of the necessary flexibility. Contrary to our expectations, we observed a U-shaped curvilinear association of *coordination need* with *technological performance*, which is measured by access to complementary resources (see Figure 6.6). Above the inflection point of 5.8, the negative effect of increasing need for coordination on *technological performance* is reduced. This positive trend above the inflection points, however, does match the negative linear correlations: as far as access to complementary resources is concerned, the optimal coordination between the alliance partners is at the lowest coordination level. We therefore find no support for hypothesis 4b; *coordination need* is not hill-shaped related to performance.

As discussed in Section 4.3.4, control mechanisms, organizational structures and performance influence one another simultaneously (Geringer and Hebert, 1989; Yan and Zeng, 1999; Goerzen, 2005). The similarity of governance structures in co-innovation alliances has an impact on a need for coordination between the partners. As a result of recurrent negotiations within the partnership, alliances have to contend with additional coordination and communication costs (García-Canal et al., 2003; Christensen et al., 2005), which explains the negative impact on *technological performance*.

When the alliance partners have different governance structures, the

partners contribute to the co-innovation by using different approaches and a variety of perspectives, which lead to greater creativity (Mannix and Neale, 2005). Creativity encourages 'out-of-the-box' thinking, leading to new methods or technologies. At the same time, coordination may constrain the team's creativity, flexibility, and development progress (Bonner et al., 2002). Involving external parties in the innovation process result in additional coordination costs (Christensen et al., 2005; Grönlund et al., 2010). The negative effects of coordination can be mitigated by the positive effect of high levels of coordination in order to implement the creative processes efficiently. Through coordination, timeliness and product quality can be improved (Bonner et al., 2002; Leenders et al., 2007, Perez-Freije and Enkel, 2007).

Figure 6.6: Coordination need and technological performance



As far as *technological performance* is concerned, the negative effect of coordination cost is the lowest in the case of either highly differing opinions regarding the desired governance structures (more rewarding innovation but at the same time more difficult cooperation) or highly similar opinions regarding the desired governance structures (easy cooperation, but less rewarding innovation). Medium levels of coordination offer the least benefit. On the one hand, low levels of coordination mean fewer coordination costs. On the other hand, in the case of high levels of coordination, we expect greater potential for integrating the co-innovation into the exiting business. Medium levels of coordination offer the least positive effects of both.

6.4 RESULTS OF THE RELATIONSHIP DRIVERS

In the regressions with *commercial performance* (see Table 6.2), the linear and curvilinear effects of the relational variables (Model 4 and Model 5, respectively) do not contribute significantly to explaining the variance. In order to explain the second dependent variable (*technological performance*, see Table 6.3), the linear and curvilinear effects of the relational variables are according to the Wald-test non-also significant. As far as the third dependent variable is concerned (*financial performance*, see Table 6.4), the linear terms of the relational variables (Model 4) add 8.6 % to the R^2 or 6.8 % to the adjusted R^2 (significant at $p < 0.1$). The quadratic terms of the relational variables do not contribute significantly. The regression results for relational scales are summarized in Table 6.6.

Table 6.6: Regression results of the relationship drivers

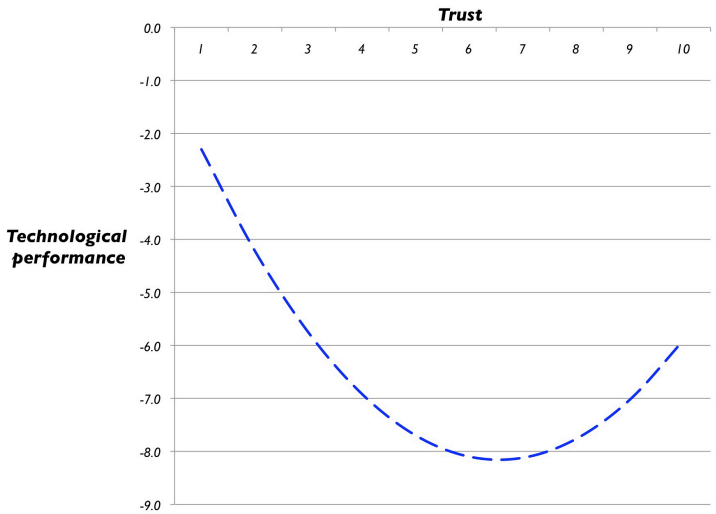
	Commercial performance	***Technological performance***	***Financial performance***
Trust	NS	U-shaped°	NS
Culture fit	NS	NS	Positive (M4)*
Technology transfer	NS	Positive (M5)°	Positive (M4)*
Firm's management involvement	NS	Positive (M4)°	NS
Partner's management involvement	NS	Negative (M5)°	NS
Technical informality	NS	NS	NS
Commercial informality	NS	NS	Positive (M4)*

Notes: NS = non significant; U-shaped = negative linear, positive quadratic effect, Hill-shaped = positive linear, negative quadratic effect. Positive, negative = positive, negative linear effect, respectively ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001, M4 = significant in Model 4, M5 = significant in Model 5.*

In **hypothesis 5**, we predicted that *trust* between partners would reveal a hill-shaped relationship with performance. We defined '*trust*' as the degree of openness between the responding company and its partners, the extent to which obligations are met by the partner, and the willingness and ability to share the expertise of the company and its partner. We did not find support for our hypothesis regarding *trust*. In contrast to our expectations, in the regression with technological performance we observed an U-shaped curvilinear effect, as illus-

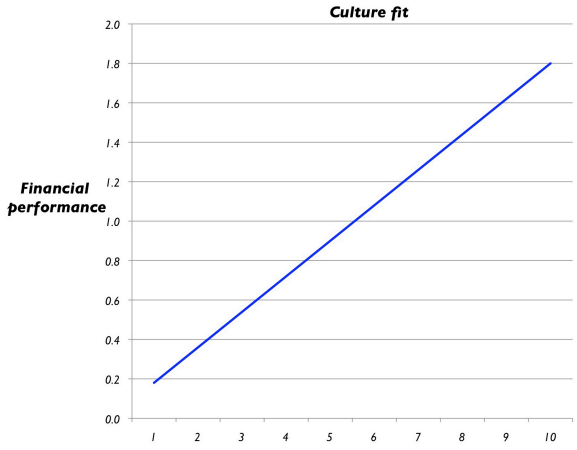
trated in Figure 6.7. As far as technological performance is concerned - measured by access to complementary resources - *trust* will cause deterioration in the results, although after an inflection point of 6.6 the negative effect will be reduced. In our research, *trust* does not correlate significantly with commercial or financial performance. The average level of trust in our research, as listed in Table 5.3 (descriptive statistics), is 7.3, when measured on a scale between 0-10, which includes a standard deviation of 1.8. We suggest that a high minimum level of *trust* might be considered as a 'conditio sine qua non' when entering into a co-innovation cooperation (Park and Ungson, 2001:51, see Box 4.4). Excessive trust between the partners will reduce the opportunities in gaining access to *complementary* resources due to the fact that the sharing of expertise between the firm and its partners becomes counterproductive leading to fewer opportunities in gaining access to the *other's* additional competences.

Figure 6.7: Trust and technological performance



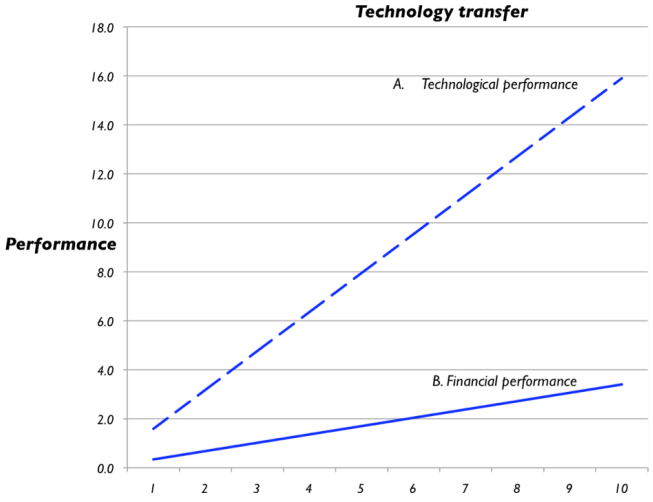
In **hypothesis 6**, we predicted *culture fit* to reveal a hill-shaped curve when related to performance. We defined *'culture fit'* as similarity of communication style, decision-making, leadership, and problem-solving style. *Culture fit* is beneficial to *financial performance*, however not hill-shaped related (see Figure 6.8). A *culture fit* facilitates routine learning and exploitation, - that is refinement and the extension of existing technology aimed at efficiency. The more the partners resemble one another in terms of communication style, decision-making, leadership, and problem-solving style, the better financial and strategic objectives can be met. We did not find any hill-shaped relationships with performance and therefore conclude that hypothesis 6 is not supported.

Figure 6.8: Culture fit and financial performance



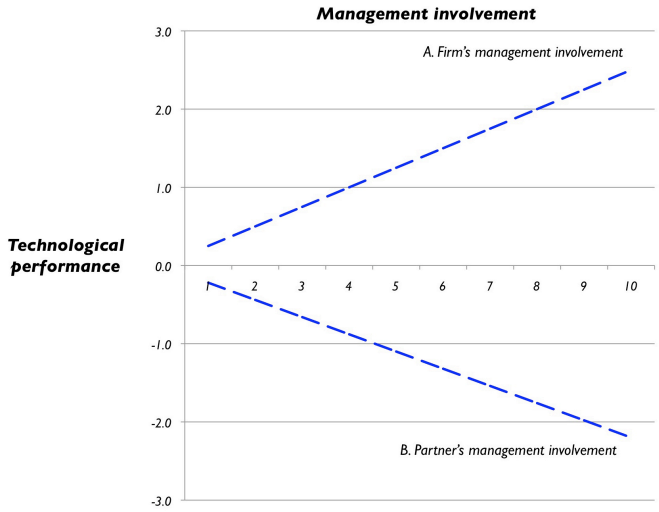
In **hypothesis 7**, we predicted the ability to *transfer of technology* to be hill-shaped when related to performance. This involves the ability to transfer knowledge (to and from external partners) as well as building and retaining relationships with external partners. We observed different positive associations in *transfer of technology,* strongly with *technological* and weakly with *financial performance* (See Figure 6.9, curves A,B, respectively). We could not find ample and robust proof for hypothesis 7 and conclude that it is not supported.

Figure 6.9: Technology transfer and performance



We expected that the effect of *involvement of a firm's management* (**hypothesis 8a**) and of the *partner's management* (**hypothesis 8b**) to be hill-shaped when related to performance. In the regressions with *technological performance* - measured by access to complementary resources, we observed opposite effects; *firm's management involvement* is considered to be positive, while a *partner's management involvement* is negative, as is illustrated in Figure 6.10, curve A and B, respectively.

Figure 6.10: Management involvement and technological performance



In this chapter, we tested our hypotheses only for linear and curvilinear (main) effects. The average level of *involvement of a firm's management* in our research, as listed in Table 5.3 (descriptive statistics), is 7.4, measured on a scale between 0-10, with a standard deviation of 2.7. We suggest that a *firm's management involvement* might be considered as a "conditio sine qua non" when starting a co-innovation alliance. In Appendix E, we explore the effect of interaction effects of management involvement, where we will discuss the influence of a *firm's management involvement* as a moderating or mediating variable. We do not find support for both hypotheses 8a and 8b regarding firm's and partner's management *involvement*; in general, no significant hill-shaped associations could be observed.

In **hypothesis 9**, we predicted that the effect of informality between a firm and its partner to be hill-shaped when related to performance. In Section 5.8, we decided to split this construct into two separate scales, technical informality (hypothesis 9a) and commercial informality (hypothesis 9b). We did not find

proof for hypothesis 9a. We observed a positive effect in Model 4 of hypothesis 9b in the regressions with financial performance. We could not detect any significant hill-shaped effects and therefore conclude that hypotheses 9a and 9b are not supported.

6.5 THE EFFECTS OF CONTROL VARIABLES

As can be observed in Table 6.2, in the regressions with *commercial performance,* the control variables (Model 1) explain 29.0 (R^2) or 25.1 % (adjusted R^2) of the variance, which is significant at $p < 0.001$. In order to explain the second dependent variable (*technological performance*, see Table 6.3), the control variables explain 21.0 % (R^2) or 18.6 % (adjusted R^2) of the variance, which is significant at the same level of $p < 0.001$. As to the third dependent variable (*financial performance*, see Table 6.4), the control variables explain 35.1 % (R^2) or 29.1 % (adjusted R^2) of the variance, which is also significant at $p < 0.001$. In Section 5.7, we derived ten control variable scales. The regression results of these scales are summarized in Table 6.7.

When considering the alliance control variables, we did not find significant effects for the role of respondent, industry, number of partners, multiple input of the *partner*, size (of the firm or its partner measured in sales or employees), size differences, partner innovativeness (estimate of the respondents), partner sales per employee, firm's importance, and initial conditions.

Neither do we find significant estimates for the market control variables: predictability, and technological intensity, nor for the strategic control variables: strategic motives (both of the firm or its partners), cost motives (both of the firm and its partner), stability, and the flexibility of the partner. In Table 6.7, we summarize the significant effects of control variables.

We calculated the duration of the projects and asked our respondents to judge the life cycle of the co-innovation project (start-up, growth, early maturity, later maturity or decline phase). In general, we observed a positive association with project duration and a hill-shaped association with project life cycle (see Figure 6.11, curves A and B, respectively).

The positive effect of project duration can be explained through the existence of learning effects: the longer a co-innovation alliance exists, the better its *financial performance*, i.e. the more strategic and financial objectives are met, which is in line with Mody (1993), Lin and Germain (1998), and Child and Yan (2003). Second, one might expect that only successful alliances will be continued, implying better performance in older projects.

Table 6.7: Regression results of the control variables

Alliance control variables			
	Commercial performance	***Technological performance***	***Financial performance***
Number of partners	Hill-shaped*	NS	NS
Project duration	NS	NS	Hill-shaped*[7]
Project life cycle	NS	NS	Hill-shaped°/**
Partner's nationality	NS	NS	Positive°/*
Multiple input of the firm	NS	Positive°/***	NS
Firm's sales per employee	NS	NS	Positive**/***
Firm's innovativeness (perception)	NS	Negative°	Positive**/***
Partner's importance	Positive**	Positive°/**	NS
Market control variables			
Knowledge concentration	NS	NS	Positive°
External turbulence	Positive*	NS	NS
Strategic control variables			
Partner's strategic motives	Negative°/*[8]	NS	NS
Technological motives	NS	Positive°/***	NS
Firm's flexibility	Negative**/***	NS	NS

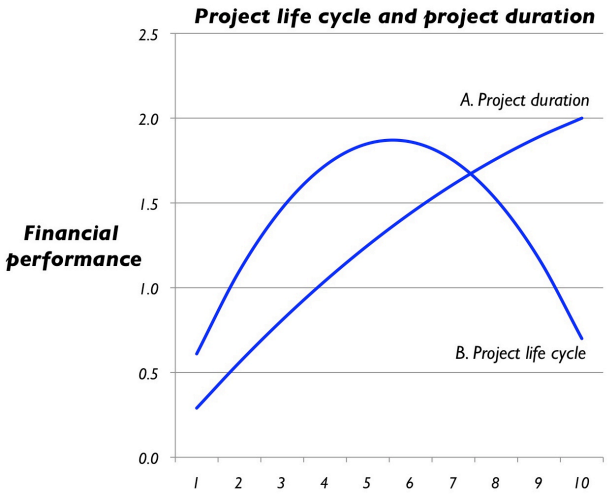
Notes: NS = non significant; U-shaped = negative linear, positive quadratic effect, Hill-shaped = positive linear, negative quadratic effect. Positive = positive linear effect, negative = negative linear effect. ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

[7] In Model 1,2, and 3.
[8] Not significant in Model 5.

In the following, we discuss the impact various control variables have on performance.

Co-innovation alliances are aimed at the development of new products and services. When a project matures (or even reaches a decline phase), one might expect that financial results deteriorate.

Figure 6.11: Project life cycle, project duration and financial Performance

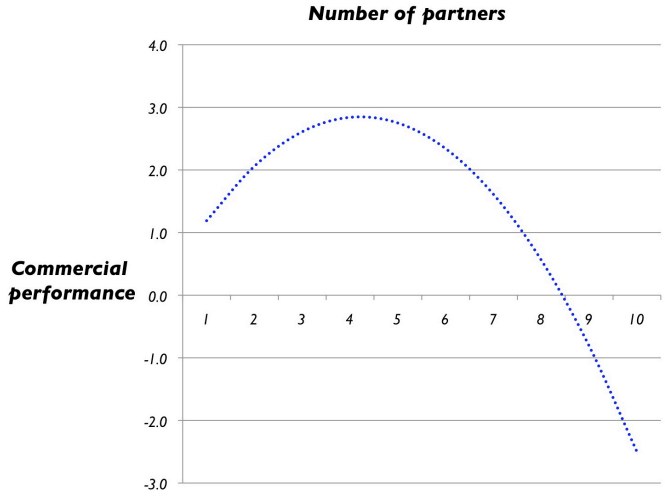


The number of partners has a significant curvilinear impact on commercial performance (See Figure 6.12). As far as the proportion of IP, profit and rights to market the products is concerned, an alliance with three partners is more attractive than with two or four partners. Within alliances that involve more than four partners, the risk of dilution of IP further reduces the commercial performance.

Similar *nationalities* of partner and focal firm have a positive effect on financial performance. When partners that share the same nationality cooperate, we can expect easier exploitation of joint activities and lower coordination cost resulting in a better chance of achieving financial objectives.

We observed a positive association of a firm's *multiple input* and the access to complementary resources *("technological performance")*. When a firm supplies *multiple input* – that is input concerning multiple aspects to the co-innovation alliance, such as commercial, technological, and financial aspects– it has more bargaining power in acquiring access to the complementary resources of the partner within the joint operation.

Figure 6.12: Number of partners and commercial performance



We found a positive association between a *firm's sales per employee* and *financial performance*. In companies with higher sales productivity, employees are more focused on exploitation (achieving targets) than on exploration (out-of-the box learning).

A perceived *firm's innovativeness* has a positive impact on *financial performance* - i.e., - the extent to which financial and strategic goals are met, while the access to complementary resources, known as *technological performance* has a negative impact. The positive association with *financial performance* is in line with Stuart (2000), who concluded that *innovativeness* has a positive impact on future sales growth. Highly innovative firms, however, will face fewer opportunities in accessing the complementary resources of their partners due to the fact that they might already be ahead of them.

The perception whether the *co-innovation project is important* affects the *commercial* and *technological performance* positively. When partners perceive the cooperation as important, the partners are more inclined to supply know how or resources to the alliance.

We observed a positive impact of two market control variables. When sources of expertise in the industrial environment of the co-innovation alliance are concentrated - i.e., only available in a few knowledge sources - the co-innovation alliance is considered to be a means of improving a firm's *financial performance* by acquiring faster and more price efficient unique knowledge: knowledge concentration affects *financial performance* positively. When the external conditions of the co-innovation project are changing rapidly, defined as *external turbulence*, the commercial benefits of the co-innovation alliance are considered to be

important. In this case, the alliance is considered to be a means of improving the firm's position in the market.

Partner's strategic motives influence the *commercial performance* of the focal firm negatively due to the fact that they strive to own rights to market the joint developed projects. When partners consider strategic and market considerations to be a major issue in order to enter into a co-innovation alliance, they will be reluctant to grant marketing and IP rights to the focal firm. The *technological motives* of both the firm and its partner contribute positively and significantly to an improvement of *technological performance* due to the fact that the partners are more eager to embay their skills in the joint operation.

A *firm's flexibility* (the ability of an organization and its management to react quickly to external variations) negatively influences *commercial performance*. In order to develop IP and introduce new products into a market, companies need perseverance and determination. Companies that are used to being flexible leave a larger proportion of market rights and IP to their partners.

6.6 SUMMARY AND CONCLUSIONS

In this chapter, we tested the hypotheses as postulated in Chapter 4 with the use of multivariate regression models. We discussed the contribution of the organizational, relational, and control variables to the explanation of performance and tested the direct effects, both linear and curvilinear. When the associations were contrary to our expectations, we clarified the differences. In the regressions with *financial performance*, we found support for our hypotheses concerning *contract need* ("negative impact") and *firm's centrality* ("hill-shaped related"). We do not find full support for the other hypotheses, as summarized in Table 6.8.

Table 6.8: Summary of the testing of the hypotheses

Predicted effect with performance	**RESULT**
Organizational variables	
Contract need: (Hypothesis 1): Negative	Full support as far as *financial performance* is concerned, with *technological performance* significant in Model 2 only.
Firm's embeddedness (Hypothesis 2a): Hill-shaped curvilinear	No support
Firm's centrality (Hypothesis 2b): Hill-shaped curvilinear	Full support as far as *financial performance* is concerned
Partner's embeddedness (Hypothesis 2c): Hill-shaped curvilinear	No support; positively related to *financial performance* in Model 2
Partner's competences (Hypothesis 3): Positive	No support: U-shaped as far as *commercial performance* is concerned
Coordination need (Hypothesis 4b): Hill-shaped curvilinear	No support: U-shaped as far as *technological performance* is concerned
Relational variables	
Trust (Hypothesis 5): Hill-shaped curvilinear	No support: U-shaped related to *technological performance*
Culture fit (Hypothesis 6): Hill-shaped curvilinear	No support: positively related to *financial performance* in Model 4
Technology transfer (Hypothesis 7): Hill-shaped curvilinear	No support: positively related to *technological performance* in Model 5 and *financial performance* in Model 4
Firm's management involvement (Hypothesis 8a): Hill-shaped curvilinear	No support: positively related to *financial performance* in Model 4
Partner management involvement (Hypothesis 8b): Hill-shaped curvilinear	No support: negatively related to *financial performance* in Model 5
Technical informality (Hypothesis 9a): Hill-shaped curvilinear	No support: positively related to *financial performance*
Commercial informality (Hypothesis 9b): Hill-shaped curvilinear	No support: positively related to *financial performance* in Model 4

Hill-shaped = positive linear, negative quadratic effect. Positive = positive linear effect, negative = negative linear effect, M4 = significant in Model 4, M5 = = significant in Model 5.

We could not find support for most of our hypotheses, which leads to the conclusion that the performance of co-innovation alliances cannot be explained universally, due to the fact that the relations of organizational and relationship drivers to performance are contingent upon various conditions that we list in Table 6.9.

Box 6.1: Explaining the performance of co-innovations alliances

1. *Different aspects of performance*
2. *Differences across industry*
3. *Performance drivers shift during of the cooperation*
4. *Indirect and direct effects interact with one another*
5. *Performance drivers might also be considered as necessary conditions*

As discussed in Section 4.2, the *performance* concept is assessed relative to the various objectives driving an alliance. We have established evidence that proves that the relevance of the identified performance indicators varies according to the type of performance. For instance, we observed a positive effect of a high ability to *transfer technology* on the access to complementary resources (*more technological performance*). At the same time, a high ability to *transfer technology* weakens the relative position towards the partner due to potential uncontrolled or excessive disclosure of information, and consequently a deteriorating of the relative ownership position as far as intellectual property is concerned (*less commercial performance* (see Figure 6.9).

We observed different relationships to performance of our independent variables across industry. *Industrial differences* play a role due to the different structure of industries. For example, in manufacturing industry, *technical informality* is to a certain extent beneficial in meeting financial objectives, whereas it is negative in the food industry due to strict food safety regulations (see Appendix D, Figure D.7b).

The relation of our indicators with performance varies according to the *duration* of the cooperation as well. For example, in mature projects, the *partner's embeddedness* has a negative impact on meeting financial objectives of the focal firm due to the fact that the effect of potential IP-leakage exceeds the novelty value of the partner's network relationships. In contrast: in young projects, *partner's embeddedness* has a positive impact on meeting financial objectives. Here, the net effect of novelty value exceeds the disadvantages (see Appendix D, Figure D.3).

Considering *indirect effects* is an essential element in the explanation of the performance of co-innovation alliances. We observed several mediating and moderating effects. For example, the ability to *transfer technology* mediates the relation of a firm's and the partner's embeddedness with performance. In the case of a high ability to *transfer technology*, a highly *embedded firm* benefits from its own network, while when a firm that has limited ability to *transfer technology*, benefits from highly *embedded partners* (See Appendix E, Figures E.6 and E.7). As

far as the access to complementary resources is concerned, a *partner's embeddedness* and a *firm's embeddedness* reinforce one another (positive moderation) while the ability to *transfer technology* in combination with *technological informality* interfere with one another (negative moderation) due to the risk of the unnecessary disclosure of information.

Some indicators may be viewed as *necessary conditions rather than performance drivers*. We measured our indicators on a scale between 0-10 and observed some high average levels (see Table 5.3, descriptive statistics): the average level of firm's management involvement was 7.4, of firm's centrality 7.4 and of trust 7.3. We suggest that a high minimum level of some indicators might be considered as a 'conditio sine qua non' when entering into a co-innovation cooperation indicating that high initial levels are a prerequisite for starting the partnership (Park and Ungson, 2001).

As indicated in Section 5.8, we discuss the existence of potential measurement errors in our regression results. We base our regressions on perceptual data that was collected in a single-method research through a self-reporting questionnaire, which may potentially generate systematic measurements errors, known as common-method variance (CMV). As discussed in Sections 5.3 and 5.9, we took several procedural remedies, conducted statistical checks and used generally accepted norms of convergent and discriminant validity in order to reduce potential CMV distortion. In order to limit the risk of CMV further, we aggregated our data and used observations of sets of responses from multiple respondents. It is highly unlikely that several respondents responded with the same bias. Furthermore, we checked the robustness of our regressions. When we consider the findings, many direct effects appear to be non-linear or should be considered in conjunction with indirect effects, which in turn reduces the chance of CMV.

In the next chapter, we will discuss the managerial implications and limitations of our research. We will elaborate on the practicalities concerning improving the performance of co-innovation alliances.

7 SUMMARY AND CONCLUSIONS

7.1 INTRODUCTION

In this chapter, we summarize our research. We identify factors and processes, which can be used in assessing the performance of co-innovation alliances and stipulate significant associations with performance. We discuss the subject of improving the performance of co-innovation alliances, the limitations in our study and suggest avenues for additional research.

7.2 SUMMARY

In Chapter 1, we introduce our research by defining key definitions, research objectives and research questions. We define co-innovation alliances as business relationships in which two or more independent firms or research institutes work cooperatively, sharing both risk and reward, in clearly defined projects that are aimed at the development and commercialization of new products or services. In our study, we develop and test a theoretical and evidence-based framework. This serves as a basis for the development of a management tool in order to diagnose and improve the performance of co-innovation alliances. We develop such a framework through the identification of factors and processes that facilitate or complicate performance in existing management research.

In Chapter 2, we discuss the relevance of our research. Customers and competitors act increasingly on a global scale, the development of new technologies becomes increasingly expensive and complex, technology life cycles shorten, and products become more knowledge-intensive. These trends imply new and intensified competition resulting in more organizational and managerial complexity. In order to deal with these implications, companies are increasingly reliant on external partners, especially for new business development, a phenomenon described by Chesbrough (2003a,b) as open innovation.

We focus our research on co-innovation alliances, in which alliance partners cooperate exclusively, usually limited to a certain period, activity or geographic location. Through this cooperation, companies seek to obtain commercial, technological, and financial advantage. Commercial advantages are - e.g., scale advantage through combining sales and market forces or distribution channels. Technological advantages can be derived though more

effective learning, resulting in a shorter time-to-market, and financial advantage through the lower cost of commercialization, or the sharing of development costs.

In Chapter 3, we discuss the contributions of four theories to the explanation of performance of co-innovation alliances. First, we use elements of the network theory; the aim and size of a network are relevant, the diversity of a network, the interdependency between partners, the structure, context and intensity of a network. We discuss networking capabilities, the differences between structural and personal embeddedness, and the dynamic aspects of networks.

Second, the resource-based view is useful as it considers firms as bundles of competences that are a difficult to imitate. Competences have a both a tangible (technical) or intangible (social) dimension, and evolve gradually. Competences should be considered at the organizational or the personal level, and can be developed internally (through internal experiences or by selecting personnel with the required competences) or externally - through the competences of partners, when companies are not able to acquire the required new internal competences in time. When knowledge is protected, sharing it with other partners becomes restricted. Existing core capabilities might evolve into core rigidities where they become counter-productive due to changing market conditions.

Third, contingency theory assumes the existence of an optimal relationship, compatibility or fit. For instance, the congruence between a market environment and an organizational form, leadership style, or a governance structure (market fit), the extent to which a firm and its partners are aligned strategically (strategic fit), whether the resources of the alliance partners complement one another in order to innovate effectively (resource fit), whether organizational routines of the partners coincide (organization fit), or the organizational cultures are well matched (culture fit).

Fourth and last, we use various constructs of organizational learning theory: absorptive capacity[1], combinative capability[2], differential learning[3], and cognitive distance[4]. Exploration and exploitation activities require both different learning styles and different optimal cognitive distance; more novelty

[1] A firm's ability to value, assimilate, and utilize new external knowledge.
[2] The ability to synthesize and apply current and newly acquired knowledge, skills and capabilities.
[3] Unequal capacities to learn from alliance partners.
[4] Explains the trade-off between novelty value and the ease of communication.

value[5] is necessary in exploration. Learning processes at the individual, group, organizational and network level differ. We discuss two fundamental paradoxes in technology transfer: the *information paradox*[6] and the *paradox of replication*[7]. Organizational learning may be enhanced through learning intent, managerial support, relational capital, learning capabilities, and the appropriate organization. Stumbling blocks in the learning process are motivational barriers, divergent goals at both the individual and organizational level, protection of knowledge, cultural differences, and organizational barriers. When learning new practices, the "unlearning" of obsolete and counterproductive practices is essential. Apart from learning, in order to prevent the risk of improper use, the protection of critical intellectual property is crucial, while at the same time maintaining an adequate balance between openness to new ideas as well as the protection of vital company interests.

In Chapter 4, we define our conceptual framework. The dependent variables in this framework are *commercial, technological* and *financial performance,* which were related to independent organizational and relationship variables. We discuss the organizational variables *contract need*[8], *embeddedness*[9]*, balanced competences*[10], and *coordination need*[11].

We predict that *contract need* is negatively associated with performance, because it complicates organizational learning and creativity, which reduces the necessary flexibility.

We predict a hill-shaped association of *embeddedness* with performance. On the one hand, *embeddedness* ensures that a firm is more attractive to potential partners, and may improve performance. On the other hand, too much *embeddedness* can lead to excessive network dependency, insufficient flexibility, and less internal learning.

We predict that *balanced competences* are positively associated with performance, because the partners depend mutually on one another's

[5] Sometimes, the term 'novelty value' may have a negative connotation, referring to a temporary or fashionable newness. We use this term in the positive sense as it is understood in the professional literature
[6] The disclosure of information in order to assess the value of information reduces the novelty value
[7] Knowledge replicated to external partners enables faster sales growth, but at the same time raises the risk of imitation.
[8] Defined as an emphasis on agreeing upon many details and a formal contract in advance.
[9] Defined as network intensity, experience, and centrality.
[10] Defined as the competences of the co-innovation alliance partners that are unique and durable.
[11] Defined as the need of both the firm and its partner to coordinate the activities within the co-innovation alliance.

resources, thus increasing their own capabilities while maintaining a balance of power. We expect a positive association with performance of similarity of *governance*, because partners with similar governance structures are better able to handle the complexities that are inherent in the co-innovation process. Similarity leads to more stability, and consequently to better performance.

We predict the *coordination need* to be hill-shaped associated to performance, because too little coordination may lead to insufficient use of complimentary resources, while too much coordination might impede the necessary flexibility, creativity and innovation.

We discuss the relational variables *trust*[12], *culture fit*[13], *transfer of technology*[14], *management support*[15], *and personal relationships*[16].

We predict *trust* between partners to have a hill-shaped relationship with performance. Trust may reduce the uncertainty of alliance partners towards one another, leading to lower governance costs, increased flexibility, commitment, and learning. However, too much trust can lead to complacency, acceptance of a less-than-satisfactory outcome, risk of malfeasance, less information exchange, or unnecessary obligations.

We predict a hill-shaped association of *culture fit* with performance due to an expected trade-off between creativity and problem solving. On the one hand, cultural similarity increases stability and facilitates problem solving. On the other hand, cultural differences are to a certain extent positive for creativity and innovation, because they may enrich the decision-making process and facilitate "unlearning" or thinking-out-of-the box.

We predict a hill-shaped association of *transfer of technology* with performance. Transfer of technology is essential both to learning and co-innovation, but in excess may lead to uncontrolled information disclosure, and a shifting balance of power, resulting in instability and underperformance.

We predict a hill-shaped association of *involvement of management* with performance because management decides upon the allocation of funds or other resources, which in turn may reduce organizational barriers. However, excessive involvement may lead to too much dependency on management, less

[12] Defined as the mutual disclosure of information, meeting obligations, and the willingness and ability to share expertise.
[13] Defined as similarity of communication styles, decision making, leaderships and problem-solving styles.
[14] Defined as the willingness and ability to transfer technology, both to and from partners and to retain relations with partners.
[15] Defined in two separate scales, a firm's management involvement and the partner's management involvement.
[16] Measured by informality between the alliance partners in two separate scales, technical informality (concerning R&D issues and projects management) and commercial informality (concerning strategic and marketing issues).

operational flexibility, less learning and a decrease in motivation of the innovation team.

We predict a hill-shaped association of *interpersonal relationships* with performance because informal contacts may strengthen interpersonal relationships and facilitate the innovation process. However, when personal relationships become familiar and too informal, loyalty of personnel might shift to other partners, causing the innovation project to become dependent on personal relationships. In addition, excessive informal contact may lead to complacency, and the acceptance of less-than-satisfactory results.

In Chapter 5, we discuss our research design. Our research objectives implied several methodological challenges and choices. We decide to conduct quantitative research using primary data, which was has a mixed hierarchical (multilevel) and non-hierarchical (cross-classified) structure. Consequently, our observations are to a certain extent correlated or nested. Because variability across respondents is not our prime research objective, we aggregated our database at the partnership level.

We check the robustness of our regression parameters with use of the Huber/White routine. In addition, we construct subsamples of our database and analyzed whether the regression results remained robust. Our research process involves the development of a conceptual model, the design and testing of a questionnaire, conducting survey-based interviews, statistical analysis and, ultimately, the construction of the definitive model.

We undertake several steps in order to reduce potential bias caused by common-method variance. We discuss our data collection process, as well as the companies, projects, partnerships and respondents that participated in our research. We assess the influence of alliance characteristics[17], market conditions[18] and strategic considerations.[19]

Before analyzing our data, we screen our dataset on missing values, outliers, sample size, and normality. We then construct our scales, using principal component analysis techniques.

In Chapter 6, we present the empirical results of our multivariate data analysis.

[17] Initial conditions, size of the firm and its partner, size differences, innovativeness, perceived importance of the project, number of partners, project life cycle, industry, and relationship of the respondent to the project.
[18] Market ambiguity, market complexity, risks, market uncertainty, importance of technological aspects, life cycle of the market, dynamism of the market, and knowledge concentration in the industry.
[19] Strategic fit, strategic flexibility and strategic stability, technological motives, and financial or cost saving drivers.

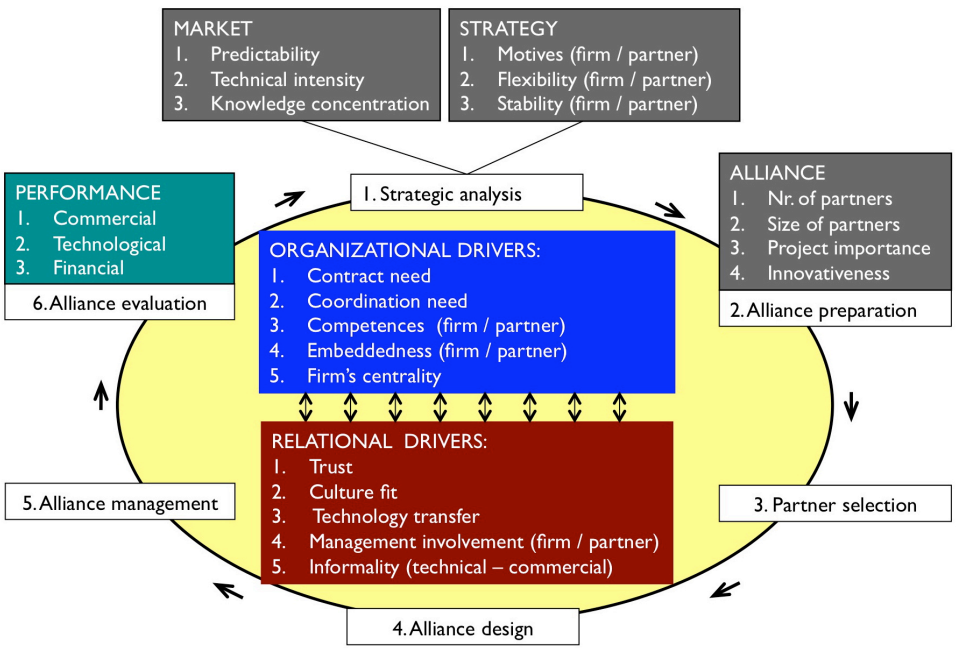
In several regression models, we include different parts of the research model and assessed the robustness of the regressions. We then decide whether or not our hypotheses are supported, as will be discussed in the following section.

7.3 CONCLUSIONS

The main objective in our study is to develop, test and explore both a theoretical and evidence-based framework in order to diagnose and explain performance in co-innovation alliances. The first research issue in our research is to identify factors and processes, which can be used in assessing the performance of co-innovation alliances.

The research results in a model containing the indicators as listed in Figure 7.1. The model serves a basis for a management tool that can be used in all of the phases: from strategic analysis, alliance preparation, partner selection co-innovation design, management, and evaluation. Market and strategy characteristics serve as input for a strategic analysis, to be followed by the preparation of a co-innovation alliance, which includes a profile of the desired partner(s). The organizational and relationships drivers can be used to select appropriate partners. In addition, they may be used in designing, managing, and evaluating the co-innovation alliance.

Figure 7.1: COINN-model related to the co-innovation cycle



The second research issue is to detect the effects of the indicators with performance and study the opportunities for performance improvement. We list the relationship to the defined performance aspects in Table 7.1.

Table 7.1: Associations with performance

	Commercial performance	***Technological performance***	***Financial performance***
Positive	*Partner's importance* *External turbulence*	*Technology transfer (M5)* *Firm's management involvement (M4)* *Multiple input* *Partner's importance* *Technological motives*	*Partner's embeddedness (M2)* *Cultural fit (M4)* *Technology transfer (M5)* *Commercial informality (M4)* *National similarity* *Sales per employee* *Firm's innovativeness* *Knowledge concentration*
Hill-shaped	*Number of partners*		*Firm's centrality* *Project duration*
Negative	*Firm's embeddedness (M2)* *Partner's strategic motives* *Firm's flexibility*	*Contract need (M2)* *Partner's management involvement (M5)* *Firm's innovativeness (M5)*	
U-shaped	*Partner's competences*	*Coordination need* *Trust*	*Contract need*

Notes: M2 = in Model 2, M4 = in model 4, M5 = in Model 5.

Following the *explanation of* the performance of co-innovation alliances, we will discuss some of the practical issues concerning the *improvement* of performance, as listed in Box 7.1.

Box 7.1: Improving the performance of co-innovations alliances

1. *Deal with paradoxes effectively*
2. *Consider various contingencies that influence one other*
3. *Be aware of shifting performance drivers during the cooperation*
4. *Co-innovation requires different individual traits and roles*
5. *In co-innovation emphasis is put on a transformational leadership style*
6. *Co-innovation demands organizational adjustments*

Improving the performance of co-innovation alliances entails the ability to manage various *paradoxes* simultaneously. Measuring and subsequently improving the performance of co-innovation alliances requires an integrated, holistic approach, in which several relevant aspects and contexts are considered simultaneously (Kerssens- van Drongelen and Cook, 1997; Westwood and Low, 2003). Improving the performance of co-innovation alliances entails the ability to manage various paradoxes simultaneously. In such an approach, several paradoxes should be dealt with; the paradox between *trust* and *control* (Dekker, 2003; De Man and Rooijakkers, 2009), between exploration and exploitation (Vanhaverbeke et al., 2003; Nooteboom et al., 2007; Rijnsdijk et al., 2009). Another paradox is between cooperation and competition within the partnership - between *"sharing and growing the pie"* (Brandenburger and Nalebuff, 1996; Hagel and Brown, 2005; Tjemkes, 2008), which results in a selective openness to the partner. In addition, variation in performance drivers per type of performance (commercial, technological and financial) may lead to paradoxes. Innovation involves both, creativity and flexibility on the one hand, and timeliness, product quality, and efficiency, on the other (Leenders et al., 2007, Perez-Freije and Enkel, 2007). For example, one should restrain from tight coordination activities in order not to limit the access to complementary resources (technological performance), however, coordination and contracts might be indispensable in order to obtain a fair share of commercial benefits or meet financial objectives. Once the paradoxes have been recognized, one should prioritize aspects, manage the balance between conflicting priorities, and accept the consequences.

As discussed in Section 6.6, the performance drivers are subject to several *contingencies*; they vary across industry and project duration. Usually in co-innovation, firms cooperate with partners that have complementary resources or competences. Partners that are active in different industries are motivated differently as performance drivers vary per industry. In addition, performance

drivers influence one another. For example, the desired level of coordination is contingent upon a *firm's* and the *partner's embeddedness*, as well as its ability to *transfer technology*, and *balanced competences* (See Appendix E). It is essential to identify the relevant conditions and understand their impact on performance.

We illustrate the complexity of improving performance of co-innovation alliances with the use of various moderation effects in Box 7.2.

Box 7.2: Example of conflicting effects in co-innovation

A combination of detailed contracts and highly coordinated activities improves the relative position of a firm towards its partner commercially. However in general, detailed contracts and coordination may reduce flexibility and therefore constrain the innovation process as well. In contrast, when a partner is highly embedded, detailed contracts with the partner do add to the financial and technological performance.

The performance drivers will change gradually during the cooperation. It is important to be aware of the *dynamic character* of performance drivers, sympathize with those changes and adapt one's strategy and behavior accordingly. For instance, trust between partners is an indispensible condition in a co-innovation alliance. Trust between the alliance partners will grow gradually by having positive joint experiences. More trust will result in more openness towards one another and involves the risk of potentially excessive disclosure of proprietary information or insufficient control.

In open innovation, the emphasis has shifted from *what* you know to *who* you know. Intensive interaction and personnel relationships between the various partners are essential (Kauser and Shaw, 2004; Leenders et al., 2007; see Section 4.4.5). In order to implement within a *"connect and develop"* approach successfully (Section 2.4), a different mix of individual attitudes, competences, and personality characteristics, is required as opposed to the traditional R & D or closed innovation practice. In order put innovation into practice, employees should be allowed to move away from a *"devil's advocate"* role and play more innovative roles, such as *"expirimenter"* or *"collaborator"* (Kelley, 2005).

In conjunction with individual differences, in co-innovation, a shift towards *transformational* as opposed to transaction leadership style can be expected. Transformational leaders tend to develop and empower their team members by providing support. They are usually charismatic, lead by example,

and stimulate their team members to adapt personal interest to the organization. By contrast, transactional leaders emphasize to clarify expectations of the team members, offer recognition when individual and group objectives are achieved. They focus on rewards or discipline, while monitoring actively deviation from standards (*"management by exception")* and taking corrective action as quickly as possible (Carless et al., 2000; Goodwin et al., 2001; Bass et al., 2003).

Implementation of co-innovation has its *effect on the organizational level* as well as co-innovation is considered to be an innovation of the business model. Value is created and captured with external entities that cooperate in innovative ecosystems (Section 2.2; Chesbrough, 2003b, 2006). The success rate of co-innovation can be increased by advanced management techniques, the use of knowledge centers in order to bundle the co-innovation expertise, as well as training or executive coaching (Bamford and Ernst, 2002; Draulans et al., 2003; Lichtenthaler and Lichtenthaler, 2004; Sampson, 2005).

In the co-innovation practice, the organizational culture should be adapted in order to transfer reluctance to learn from others, known as a "not-invented-here" mentality - to a "proudly found elsewhere" mentality (Section 2.4 and Section 3.5), resulting in an "open" culture that entails a polycentric attitude - accepting and benefiting from cultural differences between the partners (Hofstede, 1983, Section 4.4.2).

Another organizational implication is the policy towards the protecting of Intellectual Property (IP). Instead of keeping IP inside the company, it should be traded in case it is not used. Instead of developing IP without considering the alternative to buy it elsewhere, it should be developed only if strategically interests are predominant (Chesbrough, 2003a).

To summarize: improving the performance of co-innovation implies both a set of practices using external sources, as well as an open mentality (Section 2.4). We therefore consider the management of co-innovation alliances as multi-perspective-multilevel challenge and discuss the management implications of co-innovation alliances in Section 7.5.

7.4 LIMITATIONS

Given de scope of our research (see Section 1.2), it is subject to a number of limitations that we list in Table 7.2. Addressing these provides opportunity for further research.

Box 7.3: Limitations of the COINN-research

1.	*Test of dyadic relationships*
2.	*One-sided analysis*
3.	*Test of general direct effects*
4.	*Restrictions in multi-level research*
5.	*Focus on quantity of performance drivers*
6.	*Sample size constraints*

Although the co-innovation alliances in our research consist of a varied number of partners, in the process of formulating our hypotheses - due to practical reasons - we focus on *dyadic relationships* within the alliance. Relationships between three or more partners differ from dyadic relationships (Garcia-Canal et al., 2003). We do not examine the added complexity of multi-partner alliances or virtual network cooperation in depth. We use the size of a partnership as a control variable and found a significant hill-shaped association with commercial performance. Further research could analyze the dynamics of (virtual) multi-partner networks more in detail (De Man, 2004).

We collect our data of the alliances mostly through *one-sided respondents*. Although we take several precautions and took procedural remedies and statistical checks to reduce the likelihood of biases, gathering more data from the perspective of the alliance partner would have enriched our database (Kumar et al., 1993).

As third limitation of our study: we base our hypotheses on theory concerning the direct relations between organizational and relationship variables with performance and subsequently tested the hypotheses. We explore various effects of industry and project duration, as well as several indirect effects without examining the theoretical foundation of these distinctions in depth (see Appendix D and E, respectively). As we conclude that indirect effects and various contingencies play an important role in the explanation of co-innovation performance, further research could develop more detailed indicators that measure new conditional constructs.

In our *multi-level research*, we focus on relationships and organizational aspects of inter-organizational cooperation. We refrain from examining the consequences of different individual traits or team composition on the innovation outcome. We will discuss further research into these areas in the next section.

We focus on the *quantity* of performance drivers and quantified optimal levels of performance drivers - when significant - without having measured the effectiveness or quality of the drivers. For instance, we discuss the level of management involvement without considering the effects of different leadership styles that influence the innovation performance in different ways (Bartram, 2009).

We can test the effects of performance drivers on three aspects of performance only separately due to a *limited database* of 137 aggregated observations. A larger database would have enabled us to analyze the different aspects of performance in relation to one another in a Structural Equation Model (see Section 5.5) or would have made it possible to study the indirect effects in more detail (see Appendix E). In addition, in our database of 137 observations, we observe a positive linear instead of the expected hill-shaped curvilinear association with performance in the testing of six hypotheses: *partner's embeddedness, trust, culture fit, technology transfer, firm's management involvement technical informality, and commercial informality*. Additional research using a larger sample may result in significant negative quadratic associations, and consequently in the hill-shaped relations.

Last, most of the partnerships we examine were between Dutch and Belgium companies. At the national level, cultures vary on dimensions referred to as power distance, uncertainty avoidance, individuality, masculinity, and time orientation (Hofstede, 1980). Due to the different scores on these dimensions, the performance drivers in other cultures may vary. For instance, the *contract need* of Americans from the Japanese; American managers normally prefer formal contracts in order to avoid conflicts and uncertainties, whereas Japanese managers prefer mutual discussion to formal contracts (Park and Ungson, 2001, see Section 4.3.1).

7.5 IMPLICATIONS

Our research expands on the following theoretical implications.

We contribute by investigating the impact of various elements of network theory in the co-innovation context: our variable *embeddedness* used

insights concerning the size of a network, and the influence of centrality within a network. In our variables *management involvement* and *informality,* we test aspects of the intensity of a network and both structural and personal embeddedness.

We contribute to the resource-based view by observing the development of competences in a dynamic environment. We evaluate the technical and social aspects of competences at the organizational and personal level, highlight internal and external acquisition of competences, and evaluate the impact of core rigidities on co-innovation alliances.

We contribute to contingency theory by researching a number of 'fits'. Our variable *balanced competences* develops the concept of resource fit further. In addition, we investigate the influence of cultural compatibility in the variable *culture fit*, market fit in the market control variables, and strategy fit in the strategy control variables.

We contribute to organizational learning theory by elaborating on the concept of absorptive capacity (in our variable *transfer of technology*), and by using the cognitive distance and combinative capability concepts (in our drivers, *balanced competences* and *culture fit)*. Furthermore, we discuss the impact of differential learning, managerial support, and both motivational and organizational barriers on organizational learning.

Our research has the following managerial implications.

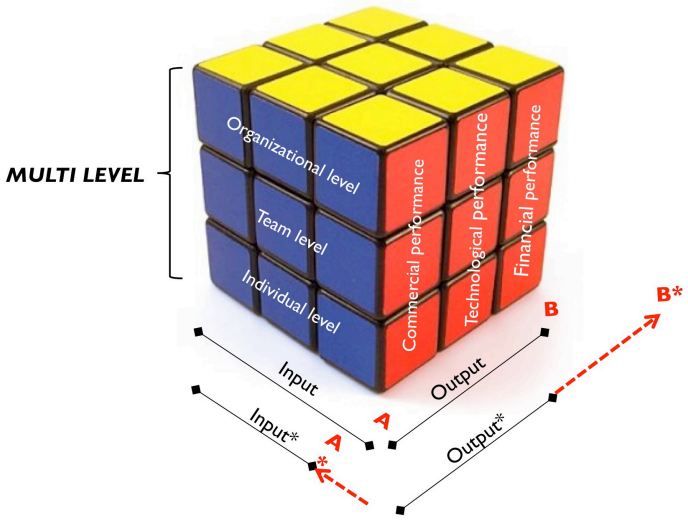
We develop a basis for a measurement system of co-innovation alliances that links performance evaluation to the objectives of the alliance. The result is a generic template that can be adapted to the specific evaluation requirements.

We identify factors and processes that facilitate or hamper the performance of a co-innovation alliance. We establish evidence that proves that the relevance of these factors varies according to the type of performance – i.e., commercial, technological and financial performance. In addition, we gather evidence that some associations with performance are curvilinear. We indicate optimal levels of drivers. By optimizing the levels of the relevant drivers at the appropriate time, the performance of co-innovation alliances can be improved.

We consider the management of a co-innovation alliance to be a multilevel and multi-faceted challenge, in which organizations, teams and individuals simultaneously interact with one another on financial and technological matters (Duysters, Heimeriks and Jurriëns,2002; García-Valerrama and Mulero-Mendigorri, 2005). The multilevel multi-perspective approach can be visualized

in an input-output model, as illustrated in Figure 7.2. By focusing attention on the appropriate levels, one can expect the sum of the total required input (point A in Figure 7.2) to be reduced to A*, with an advantage of A-A* and the sum of the total realized output (point B in Figure 7.2) to be increased to B*, with an advantage of B-B*, which represents an efficiency increase of (A-A*) x (B-B*).

Figure 7.2: The COINN-Cube



The suitability of management instruments, such as the *Balanced Scorecard (BSC)* and so-called *'stage-gate'* business development concepts, can be put to the test in the co-innovation practice. The BSC is both a strategic management as well as a control system for performance measurement, developed by Kaplan and Norton (1992, 1993, 1996a, 1996b, 2000, 2001, 2004, 2006) and considered to be a powerful and widely used management tool (Gumbus and Lyons, 2002; Bible et al., 2006). In the BSC, strategic goals are translated into measures relevant to performance, which are necessary in implementing strategy while providing a balance between the long-term strategy and short-term actions, and between financial and non-financial drivers. The BSC-concept has been evaluated in the context of performance measurement of R&D (Kerssens-van Drongelen and Bilderbeek, 1999; Li and Dalton, 2003; Bremser and Barsky, 2004; Loch, 2008; Chiesa et al., 2009) and innovation (Davila et al., 2006). However, it has not been adapted to the co-innovation context.

We propose to involve another technique in the management of R&D, innovation- or new business development projects as well: the *stage-gate approach*, in which the development process from invention to commercializa-

tion is divided into a number of stages, during which the various members of the innovation team complete clearly defined tasks simultaneously (Bell and McNamara, 1991; Cooper and Kleinschmidt, 1993; Mason and Rohner, 2002; Bremser and Barsky, 2004; Grönlund et al., 2010). In each phase, the inputs ("deliverables), criteria, and outputs are specified. The projects are then evaluated in a "gate" by a set of both quantitative and qualitative criteria, such as a strategic fit, expected financial returns, and the intellectual property position. The output represents the actual results of the gate review, enabling "gatekeepers" to decide upon whether and how to continue the project. Preceding stages evoke increased budgets, resulting in increased commitments, while risks and uncertainties are reduced (Cooper, 2008).

The process begins with the "ideation or discovery" stage, and ends with the review after introduction to the market. The sophistication of the stage-gate approach, which includes the number of phases and the size of the teams, depends on the size and risk of a development project as well as the size of a company; smaller or less risky projects in smaller companies require fewer phases and smaller teams.[20] When an idea has been specified, the feasibility of a business project is examined in stage two. In the third phase, an operational prototype is developed, which is tested in phase 4, together with the proposed business plan. In these stages, the market launch is prepared. In phase 5, the product is formally launched, while all elements of the business plan are put into practice, enabling the venture to become fully operational. In this phase, the business model is tested and refined in order to prepare the decision in a post-launch evaluation in which the decision is made whether to rollout or upscale the activities (Cooper, 2008).

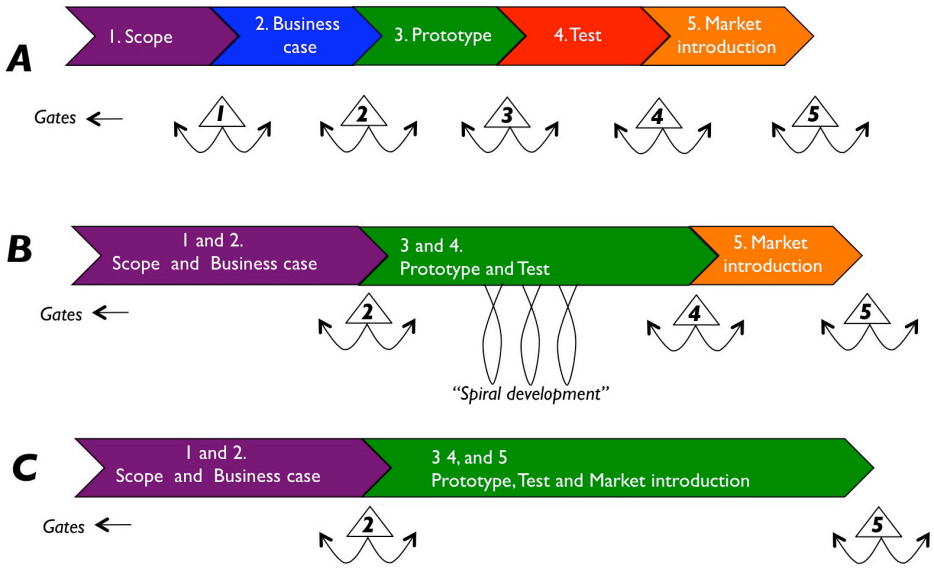
The stage-gate approach is visualized in Figure 7.3. The stage-gate approach is widely used and appreciated as it provides a structure for the implementation of new business development. If well implemented, it may speed up the new business development process (O'Connor, 1994). At the same time, it can be time-consuming, resulting in time-wasting activities, and bureaucratic or restricted learning opportunities (Sethi and Iqbal, 2008). Therefore, the efficiency and flexibility of the stage-gate approach has been improved by allowing simultaneous execution of activities, and not waiting for perfect information before moving forward (Ettlie and Elsenbach, 2007; Coo-

[20] For example, Philips uses an extended methodology, which describes explicitly per phase the tasks to be fulfilled of a business plan, a marketing plan, the business development and sales function, and the tasks of a CEO, of the future management team, and supervisory board. The methodology consists of specific checklists regarding the need for cash, finance, technology & engineering, manufacturing, logistics, and service-organization (Bell and McNamara, 1991; Mason and Rohner, 2002).

per, 2008). The stage-gate approach should not be implemented as "a rigid book of rules and procedures to be religiously followed" but allows project teams to decide upon selective execution of activities (Cooper, 2008: 224). The approach has been adapted in order to adjust to changing market conditions - e.g., by allowing rapid movement to another phase by way of a series of "build-test-feedback-and-revise" iterations, known as "spiral development" (Figure 7.3-B), in which developers incorporate customer feedback into the design in the development stage, or construct demonstration mock-ups for customers earlier in the process (Cooper, 2008).

In line with the open innovation approach (Chesbrough, 2003b) and following Grönlund et al. (2010), we adapt the BSC and the stage-gate approach in order to make it applicable to open innovation activities. By way of illustration, we have integrated the stage-gate process into our COINN-Cube model (Figure 7.4).

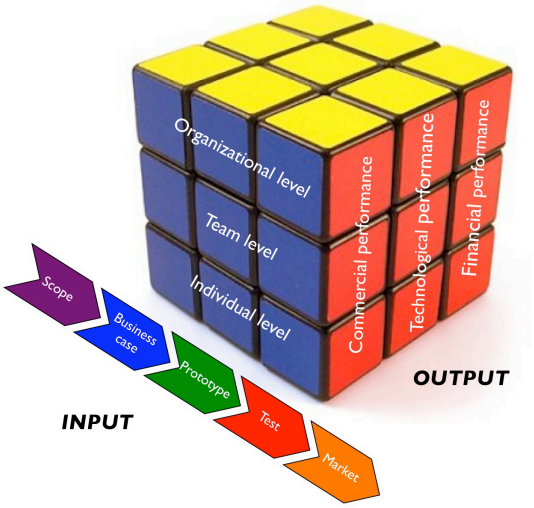
Figure 7.3: Stage-gate model of business development



Adapted from: Cooper (2008)

A stage-gate process is a business development tool, consisting of a series of stages where essential activities are put into practice. In each gate, the decision is made which activities should be continued in the following stage. The number of stages, depending on the size and risk of the projects, varies between five (situation A - e.g., large radical innovation projects in multinational companies) and two phases (situation C - e.g., small incremental innovations in small companies). Through "spiral loops" with a series of "build-test-feedback-and-revise" iterations, project teams can develop a product design more rapidly.

Figure 7.4: The COINN-Cube including the stage-gate approach



Integration of stage-gate as input factors into the COINN-model.

7.6 FURTHER RESEARCH

We therefore suggest as avenues for further research (see Table 7.3.

Box 7.4: Future co-innovation research issues

1. *Influence of individual traits on co-innovation performance*
2. *Influence of team diversity on co-innovation performance*
3. *Development of co-innovation competences*
4. *Measuring and benchmarking co-innovation*

Although individual characteristics play an important role in the implementation and performance of open innovation (Stevens and Swogger, 2009; Enkel, 2010), they have not as yet been adequately researched (Inkpen and Dinur, 1998; Mannix and Nealy, 2005).

T*eam diversity*, [21] the degree to which team members differ, may affect group process and performance positively as well as negatively. According to

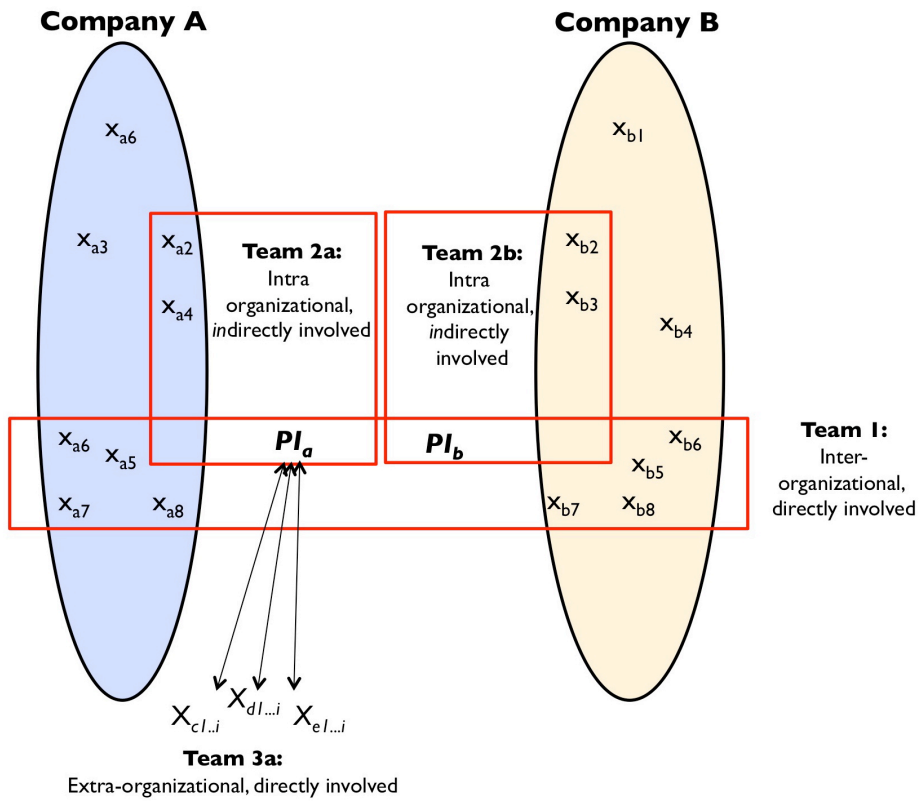
[21] Kratzer et al. (2006) refer to team diversity as "team polarity".

Trompenaars (2007), successful innovative teams make use of their diversity by sharing knowledge and expertise when executing the entire innovation process. Especially in the first and most creative phase of innovation, team diversity may enhance performance. In a later and less complex phase, however, too much diversity in the team might hamper innovation performance (Kratzer et al., 2006).

However, much is still unclear about the effects and antecedences of team diversity, such as the processes that affect performance, the contingency factors within these processes, or the role of context on team performance (Knippenberg and Schippers, 2007; Joshi and Roh, 2009; Stewart, 2010). More in-depth conceptualizing of diversity is necessary as co-innovation entails different tasks, roles and responsibilities at various aggregation levels, on the individual, team as well as on organization level.

The optimal diversity in a team depends on a team's involvement in the co-innovation project: inter-organizational, directly involved (team 1 in Figure 7.5), intra-organizational, indirectly involved (teams 2a and 2b in Figure 7.5), and extra-organizational directly involved (teams 3a and 3b in Figure 7.5).

Figure 7.5: Team involvement in co-innovation projects



Another aspect is the relation between team diversity and individual traits as personality traits of a team's members influence whether team diversity has a beneficial or detrimental effect on innovation performance. At the same time, the diversity in a team may determine which individual characteristics are beneficial to team results.

The impact and antecedents of team diversity and individual competences on innovation outcome have so far been researched usually separately. Following Kearney et al. (2009) and Stewart (2010), we argue that integrating these perspectives would be highly useful. We therefore propose an in-depth multi-level study of diversity, which includes dynamic and interactional effects between the individual and team level, together with the effects of various innovation contexts (Boone and van Witteloostuijn, 2007; Buyl et al., 2010).

In the analysis, the potential for transformational and transactional leadership could be included as well as various functions of leadership, such as vision development, communication of the goals, to gain support and, ultimately, to deliver operational results (Bartram, 2009, 2010). We expect that desired individual attitudes, skills, and personality characteristics vary in different phases in the innovation or in the case of different types of innovation (open as opposed to closed innovation or radical vis-à-vis incremental innovation). A misfit between personal characteristics and a situation increases the likelihood of failure. Therefore, risk factors due to a lack of relevant knowledge or skill could be analyzed as well.

In order to assess the characteristics of *functional diversity*, several concepts for assessing individuals and teams are widely used, tested and validated, such as the Myers-Brigg Type Indicator MBTI and the so-called Big Five model. These models describe generic individual preferences for behavior and attitude, such as a preferred problem-solving style, but do not discuss *specific* individual competences, such as the capacity to deal with people who may have a different approach. In order to measure competencies,[22] considered to be essential to job performance in the co-innovation context, *a more detailed* assessment is essential, such as the 'criterion-centric' approach, which analyzes both individual and team performance based on performance criteria (Driessen, 2005; Bartram, 2005, 2006; Trompenaars, 2007; von Stamm, 2008), for instance through the Occupational Preference Questionnaire instrument (OPQ)-instrument.

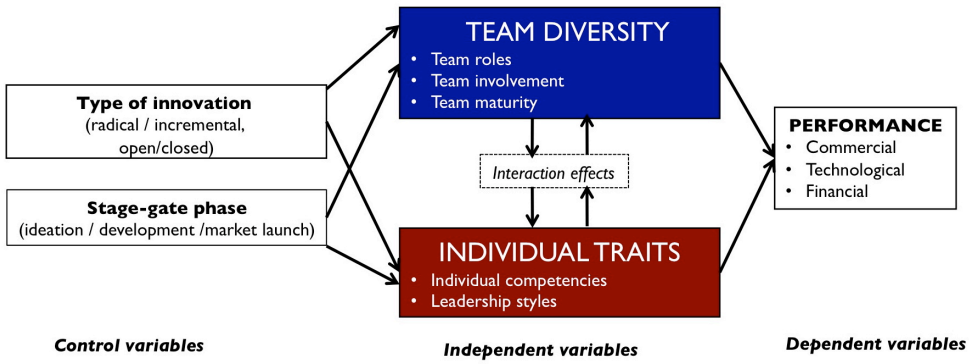
[22] Baily, Bartram and Kurz, (2001) define competencies as "sets of behaviors that are instrumental in the delivery of the desired results". According to them, this construct differs from the "competence" construct; the latter relates to performance and involves the description of tasks, functions and objectives, whereas competencies focus on the necessary behavior in order to perform.

When dealing with group diversity in innovation teams, the Belbin-theory could be used (Belbin 1991; Dulewicz, 1995), as well as the Kirton Adaptation-Inventory Index (Kirton, 2003), or the innovative roles that are described by Kelley (2005). These instruments can assist managers in effectively dealing with individual differences within teams (Trompenaars, 2007, 2009).

Although the usefulness of competencies is context-specific, almost no research evidence is known about the effectiveness in different situations (Bartram, 2010: 11).

In Figure 7.6, we integrate the proposed multilevel research on performance drivers at both individual and team level. We include dynamic and interactional effects and contextual factors as control variables as well (Boone and van Witteloostuijn, 2007, Buyl et al., 2010).

Figure 7.6: Future research on individual traits and team diversity



As third line of additional research, we propose an evaluation of instruments aimed at the *development of co-innovational competencies* at the individual and team level. Measuring co-innovation performance is more than choosing a standard set of metrics, such as BSC or stage-gate approach; it is not the choice of a metrification system that determines its success, but an effective implementation (Kerssens-van Drongelen and Bilderbeek, 1999), for which empowerment and motivation of personnel are essential (Loch, 2008). In the co-innovation context, social skills, which include reflection on one's own emotions, values and standards, are essential.

The development of co-innovational competencies at the individual and team level could be enhanced through training or coaching at the individual or team level. The added value, limitations and effectiveness of these

instruments could be evaluated in the different phases, aspects and teams of the co-innovation. Coaching differs from training, in that training refers to the acquisition of knowledge or skills by means of instruction, while coaching is generally defined as a "process of equipping people with the tools, knowledge, and opportunities they need to develop themselves in order to become more effective" (Feldman and Lankau, 2005: 830). Executive coaching has become an important managerial instrument of support (Hackman and Wageman, 2005; Leedham, 205; Agarwal et al., 2009; Stevens and Swogger, 2009a,b). At the same time, there is clearly a lack of research concerning the effectiveness of executive coaching (Evers et al., 2006).

As last avenue for further research, the suitability of *benchmarking techniques* can be tested in the co-innovation practice by way of the Data Envelopment Analysis (DEA), which identifies best practices by measuring the relative performance of a single case compared with a 'best-practice' (Zhu, 2003; Cooper et al., 2007). The DEA technique measures the relative performance - i.e., the position of a single case vis-à-vis the best practice. DEA is a linear programming method and managerial tool for assessing the efficiency, productivity or performance of units. In order to facilitate management in R&D organizations, the DEA-technique has been used in combination with the BSC-methodology (Kuang-Hua Hsu, 2005; Eilat et al., 2006a,b; Chen and Chen, 2007; García-Valderrama et al., 2009). However, a DEA-benchmark study in co-innovation alliances has not as yet been carried out. With such a study, the advantages that are indicated in Figure 7.4, could be further quantified.

8. VERBETERING van de PRESTATIES van CO-INNOVATIE ALLIANTIES

Effectieve samenwerking met nieuwe zaken partners

Zonder twijfel kan open innovatie, waarbij externe kennis in het innovatieproces wordt toegepast, de prestaties van nieuwe business ontwikkeling verbeteren. Het vergroot het rendement van productontwikkeling, versnelt de marktintroductie en verlaagt de ontwikkelingskosten. Open innovatie wordt daarom beschouwd als het dominante innovatie model voor de toekomst (Hoofdstuk 1). We onderzoeken co-innovatie allianties, waarin twee of meer onafhankelijke bedrijven of onderzoeksinstellingen samenwerken aan een specifiek project, dat gericht is op de ontwikkeling en commercialisering van nieuwe producten of diensten, terwijl ze het risico en rendement van het project delen. Helaas is open innovatie moeilijk te implementeren, omdat er sprake is van extra complexiteit (Hoofdstuk 2).

De belangrijkste doelstelling van deze studie is het ontwikkelen en toetsen van een model waarmee de prestaties van co-innovatie allianties kunnen worden gemeten en verbeterd. Op grond hiervan wordt een managementinstrument ontwikkeld waarmee verschillende projecten en partnerschappen met elkaar vergeleken kunnen worden.

De onderzoeksvragen waren:

(1) *Welke factoren en processen spelen een rol bij de diagnose en bij het management van co-innovatie allianties?*

(2) *In hoeverre verschillen deze bij verschillende doelstellingen (commercieel, technologisch of financieel) ?*

(3) *Welke veranderingen leiden tot hogere prestaties?*

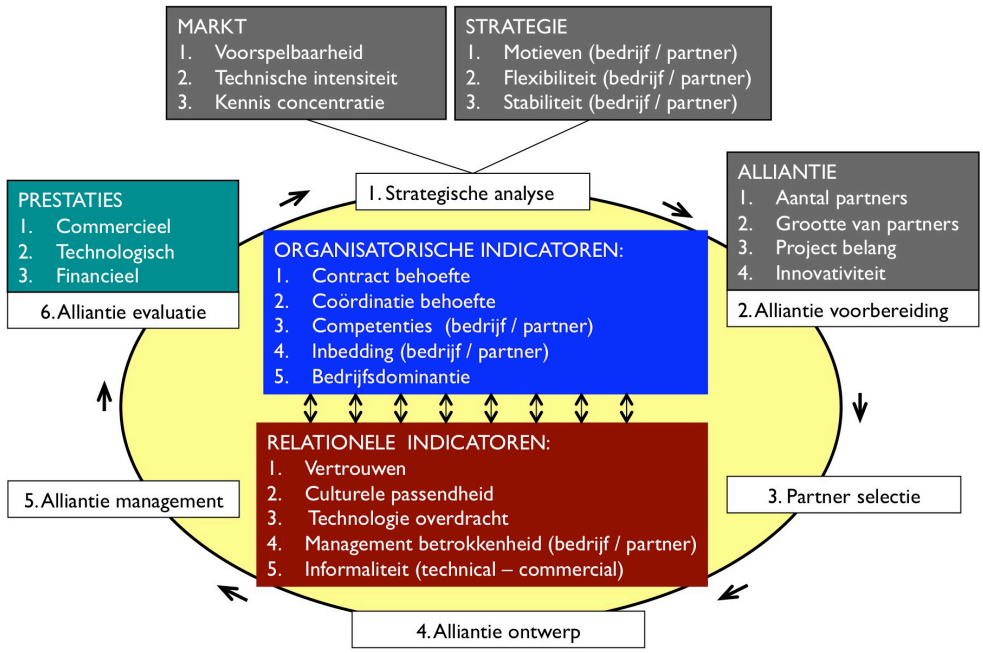
(4) *Hoe verhouden de factoren en processen zich tot elkaar?*

In de studie worden faciliterende en blokkerende factoren en processen besproken uit de netwerk-, competentie-, contingentie- en organisatieleertheorie (Hoofdstuk 3). Ook worden de resultaten gebruikt van eerder onderzoek naar joint ventures, strategische allianties en inter-organisatorische samenwerking. Gebaseerd op deze invalshoeken worden hypotheses geformuleerd (Hoofdstuk 4).

Met component analyse zijn verschillende schalen geconstrueerd: *contractbehoefte, coördinatiebehoefte, evenwichtige competenties, inbedding, bedrijfsdominantie, overeenkomstige managementstructuur, vertrouwen, culturele passendheid, technologieoverdracht, betrokkenheid van het management en informele relaties (Hoofdstuk 5).*

Er is een model ontwikkeld betreffende de invloed van de schalen op de prestaties van co-innovatie allianties in verschillende fasen van de co-innovatie cyclus: bij de strategische analyse, de voorbereiding van de alliantie, de keuze van partners, het ontwerp, management en de evaluatie van co-innovatie allianties. Daarnaast is de invloed onderzocht van verschillende marktcondities, strategie- en alliantiekarakteristieken op het model. Figuur 8.1 relateert het COINN model aan de co-innovatie cyclus.

Figuur 8.1: COINN model gerelateerd aan de co-innovatie cyclus



Gebaseerd op gegevens van 137 co-innovatie partnerschappen van 51 bedrijven en met gebruik van multivariate regressieanalyse zijn hypotheses getoetst. De studie vindt bewijs voor verschillende directe lineaire en curvilineaire verbanden (Hoofdstuk 6).

Deze relaties verschillen sterk per *type prestatie* (commercieel, technologisch of financieel). Zo hebben we bijvoorbeeld enerzijds een significant positief effect vastgesteld tussen een hoog vermogen tot technologie overdracht en de toegang tot aanvullende middelen van de partner (*"technologische prestaties"*) en anderzijds een negatief effect met *commerciële prestaties*. Een hoog vermogen om technologie over te dragen kan de relatieve positie ten opzichte van de partner doen verslechteren als gevolg van mogelijke ongecontroleerde of overmatige

openbaarmaking van informatie (Paragraaf 6.6).

Ook zijn er verschillen per *industrietak*. Zo constateren we dat informaliteit ten aanzien technische aspecten in de maakindustrie tot op zekere hoogte nuttig is om financiële doelstellingen te bereiken, terwijl dit in de voedingsindustrie negatief uit pakt vanwege de strikte regelgeving omtrent voedselveiligheid (Bijlage D).

Daarnaast veranderen optimale niveaus van de prestatie-indicatoren gedurende de *looptijd* van een project. In kortdurende projecten heeft de inbedding van een partner in een groter netwerk bijvoorbeeld een positief effect op het bereiken van financiële doelstellingen van de onderneming, maar in langdurige projecten een negatief effect. De meerwaarde van het netwerk van de partner neemt gedurende de samenwerking af, terwijl de kans op weglekken van cruciale informatie toeneemt (Bijlage D).

Tevens hebben we meerdere *indirecte* verbanden geïdentificeerd. Bij voorbeeld: bedrijven die goed technologie kunnen overdragen, profiteren meer van het eigen netwerk, terwijl bedrijven die beperkte vaardigheden hebben om technologie over te dragen een groter netwerk nodig hebben en dan ook sterker van het netwerk van hun partners profiteren (Bijlage E).

In ons onderzoek scoren de niveaus van het *betrokkenheid van het management* van de responderende ondernemingen, de *dominantie van de onderneming* en *vertrouwen* uitzonderlijk hoog. Hoge initiële niveaus van deze indicatoren kunnen als voorwaarde voor het starten van een co-innovatie samenwerking beschouwd worden (Paragraaf 6.6).

We beschouwen het management van de co-innovatie allianties als een vraagstuk dat simultaan vanuit meerdere perspectieven (het commerciële, technologische en financiële perspectief) en op meerdere niveaus (het individuele, team en organisatie niveau) belicht moet worden. Het meten en vervolgens verbeteren van de prestaties van co-innovatie allianties vraagt om een geïntegreerde, holistische aanpak, waarbij verschillende relevante aspecten en contexten *gelijktijdig* moeten worden beschouwd.

Innovatie omvat zowel de aspecten van creativiteit en flexibiliteit als ook aspecten als productkwaliteit en productie-efficiëntie. Dit impliceert de noodzaak om effectief om te gaan met een aantal paradoxen: bij voorbeeld de paradox van vertrouwen en controle van aandacht voor exploratie en exploitatie. De paradox van samenwerking en concurrentie binnen de alliantie resulteert in een selectieve openheid naar de partner (Paragraaf 7.3).

Daarnaast leiden de verschillende relaties van de prestatie-indicatoren met commerciële, technologische en financiële prestatie tot *paradoxen*. Zo beperkt een strakke coördinatie van activiteiten de toegang tot aanvullende middelen *("technologische prestaties"),* maar kan deze onontbeerlijk zijn voor het verkrijgen van een billijk aandeel van de commerciële voordelen of het bereiken van de financiële doelstellingen. Het is van belang deze paradoxen te herkennen en bewust de aspecten te kiezen die prioriteit verdienen, de consequenties van de keuzes in te schatten en het dynamische evenwicht tussen tegenstrijdige prioriteiten te managen (Paragraaf 7.3).

In co-innovatie allianties werken ondernemingen vaak samen met partners uit andere branches, aangezien deze aanvullende middelen hebben. Omdat de prestatie-indicatoren verschillen per bedrijfstak zijn partners die actief zijn in verschillende bedrijfstakken ook verschillend gemotiveerd. Bovendien beïnvloeden prestatie-indicatoren elkaar. Het gewenste niveau van coördinatie is bijvoorbeeld afhankelijk van inbedding van de onderneming en diens partner, maar ook van de vaardigheid technologie over te dragen en de mate waarin de competenties van het bedrijf en de partner duurzaam uniek zijn (Paragraaf 7.3).

Het is essentieel om de *relevante randvoorwaarden* van de prestatie-indicatoren te identificeren en hun invloed op de prestaties te begrijpen. Bij voorbeeld: een combinatie van gedetailleerde contracten en een hoge mate van coördinatie verbetert de relatieve positie van een onderneming ten opzichte van haar partner wat betreft de commerciële prestaties. Daarentegen verminderen gedetailleerde contracten en een hoge mate van coördinatie van activiteiten de flexibiliteit, waardoor het innovatieproces bemoeilijkt wordt. Wanneer een partner sterk is ingebed, kunnen gedetailleerde contracten met de partner de mate waarin financiële doelstellingen behaald worden vergroten, evenals de toegang tot aanvullende middelen van de partner ("technologische prestatie").

Daarnaast is het van belang om zich bewust te zijn van het *dynamische karakter* van prestatie-indicatoren, op deze veranderingen in te spelen en strategie en gedrag hierop aan te passen. Vertrouwen tussen de partners is bijvoorbeeld een noodzakelijke voorwaarde in een co-innovatie alliantie. Vertrouwen tussen de alliantiepartners zal geleidelijk toenemen door het hebben van gezamenlijke positieve ervaringen. Meer vertrouwen zal resulteren in meer openheid naar elkaar toe, maar brengt ook het risico met zich mee van te veel openbaarmaking van vertrouwelijke informatie (Paragrafen 4.4.1 en 7.3).

Het verbeteren van de prestaties van co-innovatie heeft organisatorische en personele implicaties.

Bij co-innovatie is sprake van een aanpassing van het business model: er wordt waarde gecreëerd met behulp van samenwerking met externe entiteiten in innovatieve ecosystemen (Paragraaf 2.2). Het slagingspercentage van co-innova-

tie kan worden verhoogd door middel van geavanceerde management technieken, het gebruik van een co-innovatie expertisecentrum, opleiding of coaching (Paragraaf 7.3).

Een andere organisatorische aanpassing is ten aanzien van het omgaan met intellectueel eigendom (IP). Door middel van open innovatie wordt externe kennis intern gebruikt ("outside-in") en intern ontwikkelde IP verkocht aan externe partijen ("inside-out"). Deze nieuwe activiteiten moeten worden georganiseerd, terwijl het binnen een bedrijf ontwikkelen van nieuwe IP beperkt blijft tot strategische kennis (Paragrafen 2.2, 2.4 en 7.3).

Succesvol implementeren van open innovatie vereist andere taken en rollen, waarvoor een andere mix van individuele attitudes, competenties en persoonskenmerken nodig is in vergelijking tot de traditionele gesloten innovatie. Zo is een "open" organisatiecultuur van belang waarin culturele verschillen tussen de partners aanvaard en benut worden. Weerstanden ten gevolge van een *"not-invented-here"* mentaliteit maken in dit geval plaats voor een *"proudly-found-elsewhere"* mentaliteit (paragrafen 2.4, 3.5 en 4.4.2).

In open innovatie is het accent verschoven van *wat je weet naar wie je kent*. Hierbij zijn goede personele relaties tussen de verschillende partners essentieel (zie Paragraaf 4.4.5). Hierin verschilt de zogenaamde *Connect & Develop benadering* van traditionele *Research & Development* (Paragraaf 2.4). Vanwege de grotere nadruk op persoonlijke relaties kan verwacht worden dat een ondersteunende leiderschapsstijl tot meer resultaten leidt dan een controlerende leiderschapsstijl (*"transformationeel"* in plaats van *"transactioneel leiderschap*", Paragrafen 7.3 en 7.6).

Ons onderzoek kent een aantal beperkingen, die aanleiding geven tot verder onderzoek.

We hebben ons beperkt tot relaties tussen *twee partijen*. Allianties met meerdere partijen vertonen aanvullende complexiteit. Verder onderzoek zou de dynamiek van de (virtuele) multi-partner netwerken meer in detail kunnen analyseren.

Daarnaast hebben we onze analyse voornamelijk vanuit het *gezichtspunt* van het responderende bedrijf gemaakt, zonder het perspectief van de partner te onderzoeken. Hoewel we een aantal procedurele voorzorgsmaatregelen hebben genomen en statistische controles hebben uitgevoerd om de kans op de zogenaamde *Common Method Variance* vertekening[1] te verminderen, zou het verzamelen van meer gegevens vanuit het perspectief van de alliantie partner onze data-

[1] Variantie die is toe te schrijven aan de meetmethode in plaats van aan de te meten constructen, zie Paragraaf 5.3.

base hebben verrijkt.

Voorts hebben we *alleen directe effecten* getoetst. We hebben effecten van bedrijfstakken en de duur van het project verkend evenals een aantal indirecte effecten. We kwamen tot de conclusie dat bedrijfstak, projectduur en indirecte effecten een belangrijke rol spelen bij de verklaring van co-innovatie prestaties, maar hebben de theoretische onderbouwing hiervan niet nader onderzocht. Nader onderzoek zou meer gedetailleerde indicatoren kunnen opleveren.

In onze research hebben we ons gericht op de effecten van relaties en inter-organisatorische samenwerking op prestatie. We hebben afgezien van onderzoek naar de gevolgen van verschillende *individuele eigenschappen* of samenstelling van *teams* op de resultaten.

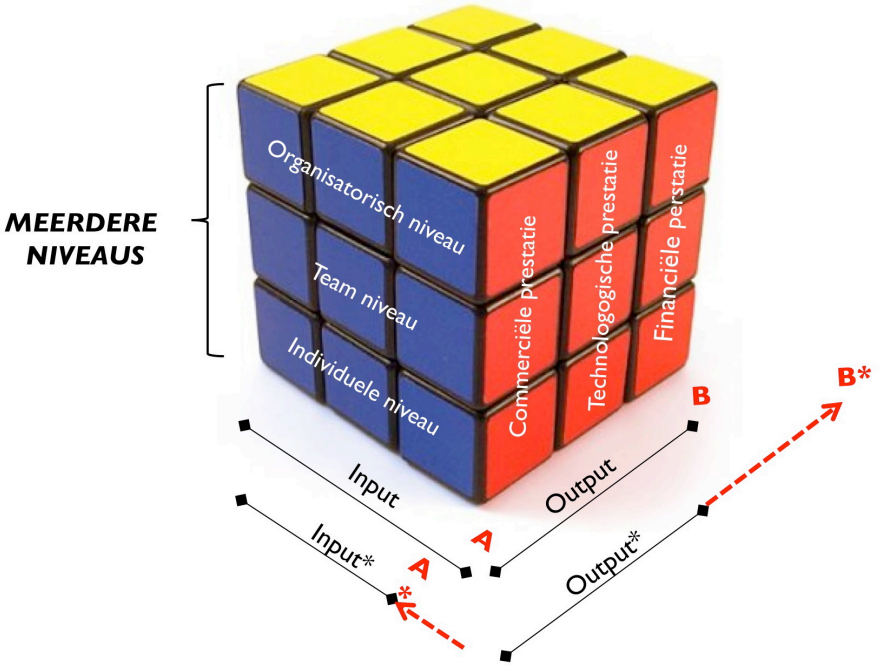
We richten ons op het kwantificeren van de optimale niveaus van de prestaties indicatoren zonder de effectiviteit of de *kwaliteit* van deze indicatoren te meten. We bespreken de *hoeveelheid* betrokkenheid van het management zonder de effecten van verschillende leiderschapsstijlen te belichten.

We baseren onze conclusies op 137 partnerships. Een *grotere database* zou ons in staat hebben gesteld de verschillende aspecten van de prestaties te analyseren in relatie tot elkaar in een Structural Equation Model (Paragraaf 5.5) of zou het mogelijk hebben gemaakt om de indirecte effecten in meer detail te bestuderen. Bovendien constateren we een aantal positieve lineaire verbanden met prestaties in plaats van de verwachte heuvelvormige (namelijk bij *inbedding van de partner, vertrouwen, culturele passendheid, overdracht van technologie, betrokkenheid van het management en informaliteit*). Aanvullend onderzoek zou kunnen leiden tot de verwachte heuvelvormige verbanden indien ook de kwadratische relaties significant zouden zijn.

Ons onderzoek heeft de volgende implicaties voor het management. We hebben een basis ontwikkeld voor een meetsysteem voor het evalueren en verbeteren van de prestatie van co-innovatie allianties. Het resultaat is een algemeen systeem dat kan worden aangepast aan bedrijfsspecifieke vereisten van beoordeling.

Wij beschouwen het management van een co-innovatie alliantie als een vraagstuk, waarbij meerdere niveaus en meerdere aspecten op elkaar inwerken: individuen, team en organisaties, interacteren op commerciële, technologische en financiële aspecten, zoals gevisualiseerd in de COINN kubus in figuur 8.2. Door de prestatie-indicatoren te doseren op de juiste niveaus, is te verwachten dat de som van de totale benodigde input (punt A in figuur 8.2) wordt verlaagd tot A*, met een voordeel van AA* en de som van de totale gerealiseerde output (punt B in Figuur 8.2) wordt verhoogd tot B*, met een voordeel van BB* en een rendementsverhoging van (AA*) x (BB*).

Figuur 8.2: De COINN kubus



In lijn met de open innovatie aanpak integreren we enkele beproefde technieken in het COINN kubus denkmodel: de *Balanced Scorecard (BSC)* en het zogenaamde *Stage-gate* business development concept.

De *BSC* wordt beschouwd als een krachtig instrument voor het meten en verbeteren van prestaties (Paragraaf 7.5). In de BSC worden strategische doelen vertaald in de benodigde maatregelen, waarbij deze in balans moeten zijn, zowel wat betreft de financiële als de niet-financiële factoren. Het *BSC*-concept is gebruikt bij het meten van prestaties van R & D afdelingen en bij innovatie in het algemeen, maar nog niet in de co-innovatie context.

Daarnaast betrekken we de *Stage-Gate* benadering in ons meetsysteem. Hierbij wordt het proces van uitvinding tot commercialisering verdeeld in een aantal stadia, waarin de verschillende leden van de innovatie-team gelijktijdig taken uitvoeren. In elke fase worden de input criteria ("deliverables) en output-criteria aangegeven. In elke “gate”, wordt de beslissing genomen welke activiteiten moeten worden voortgezet in de volgende fase. Het aantal fasen is afhankelijk van de grootte en het risico van de projecten (Paragraaf 7.5).

We doen vier suggesties voor verder onderzoek.

Allereerst is het zinvol de invloed van *individuele kenmerken* op co-innovatie prestaties nader te onderzoeken. Hoewel deze een belangrijke rol spelen bij

de implementatie van open innovatie zijn ze nog niet in detail onderzocht.

Daarnaast stellen we voor de invloed van de *diversiteit in teams* nader te onderzoeken. We verwachten dat de optimale diversiteit in een team afhankelijk zijn van de relatie van een team tot de co-innovatieproject, de persoonlijkheidskenmerken van de teamleden, de fase van de innovatie en het type innovatie.

Het is niet zozeer alleen de keuze van een meetsysteem dat het succes van co-innovatie bepaalt, maar vooral een effectieve uitvoering ervan. Om dit mogelijk te maken zijn voldoende co-innovatie *competenties* op individueel en teamniveau onontbeerlijk. Daarom stellen we voor als derde lijn van aanvullend onderzoek de effectiviteit te onderzoeken van instrumenten die gericht zijn op de ontwikkeling van deze competenties, zoals coaching en training.

Als laatste suggestie voor nader onderzoek stellen we voor de geschiktheid van specifieke *benchmarking technieken* te onderzoeken in de co-innovatie praktijk, bij voorbeeld de Data Envelopment Analysis, die *'best practices'* identificeert door het meten van de relatieve prestatie van individuele ten opzichte van vergelijkbare cases (Paragraaf 7.6).

APPENDIX A: QUESTIONNAIRE

PERFORMANCE IMPROVEMENT OF CO-INNOVATION
Co-Innovation can boost the performance of your innovation activities. Through collaborating with outsiders—knowledge sources, customers, and even competitors—a firm can import lower-cost technology from the best sources in the world, increase it innovation output, introduce innovative products and services faster to the market. But Co-innovation can also evolve problematic: it has a relatively high failure risk. To prevent promising projects ultimately will under-perform, we are developing a diagnosis- and management-instrument: the "**Co-Innovation Scorecard" COINN**.

With this instrument, managers can increase the performance and success rate of their Co-innovation projects: Best practices and *critical success factors will be identified for screening and evaluating of Co-innovation partners and –projects.*

The research is a cooperation between universities and innovative companies. The research is organized by the University of Groningen - CreateNewBusiness BV (drs Frans Stel) and supervised by prof. dr. A. Van Witteloostuijn (University of Antwerp and Utrecht) and prof.dr. E. Brouwer (University of Tilburg).

Participating companies receive (at no charge!):
1. A general benchmark report that contains best practices and success factors,
2. An analysis containing strengths/weaknesses of participating projects,
3. If desired, a visit by the researchers to clarify the research results and conclusions.

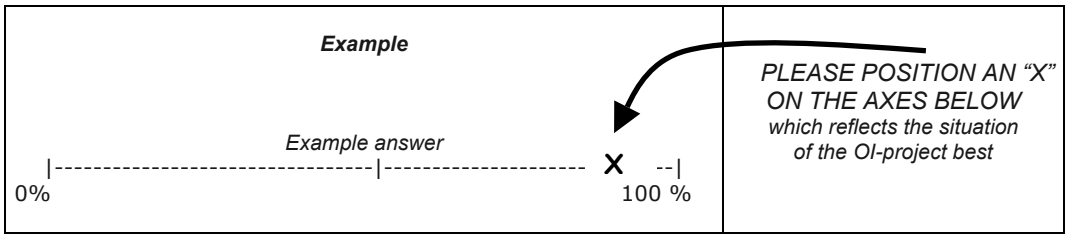
We're evaluating **the projects**:
1. aimed at development of innovative products and services,
2. with at least 2 risk / reward sharing partners,

We're examining the personal opinions and perceptions of managers. Answering will take 30 minutes. Your data will be treated confidentially and anonymously. A "Non Disclosure Agreement" will be signed on request. Only the generalized statistical scores will be published in scientific articles and a thesis. For more information, please visit: www.COINN.eu, for questions: info@coinn.eu

We measure co-innovation with a specific partner. Please use for projects with more partners one questionnaire per partner.

Our study covers 6 sections: general characteristics, market-environment, strategy, organization, relations and performance.

In order to facilitate your answering, please give your opinion on axes by positioning an "X":



Thank you in advance for your cooperation!

Drs Frans Stel, research coordinator
Sept. 2008

1. GENERAL CHARACTERISTICS

1.1 What is the name of your FIRM?
1.2 What is your name:
1.3 What is your job title:

FIRM = the part of your firm which acts as contract party in the project, e.g. Business Unit of Line

1.4 What is your relation to the project?

- ☐ Responsible for the day-to-day operations of the project including contacts with the partner
- ☐ Ultimately responsible for strategic decisions of the project (continuation, funding, ending)
- ☐ Advising management about the project
- ☐ Other: ……..

1.5 To which E-mail address can we send the research results:

1.6 What is your company's address:

1.7 What is the industry of the project? ***(you can select more than one)***

- ☐ Aerospace
- ☐ Agriculture
- ☐ Automotive
- ☐ Chemicals, oil and gas
- ☐ Consumer packaged goods / retail
- ☐ Defense
- ☐ Electronics / computing
- ☐ Financial services
- ☐ Healthcare
- ☐ Media
- ☐ Metal products
- ☐ Office automation
- ☐ Pharmaceuticals
- ☐ Semiconductors
- ☐ Telecom
- ☐ Transport
- ☐ Utilities
- ☐ Water management
- ☐ Other.

1.8. What is the start year of the <u>activities</u> of the project? *Start year is: ….*

Start year: calendar year in which of the first discussions with your partner, regardless of the juridical status of the proposed joint activities

1.9 What is the lifecycle phase of your PROJECT ?

life cycle phase of PROJECT
|----------|----------|
STARTUP *DECLINE*

0 = startup phase
25 = growth phase
50 = early maturity phase
75 = late maturity phase
100 = decline /restructuring

1.10 What is the number of risk/reward sharing partners in the Co-innovation Project? …

1.11 PLEASE SELECT <u>ONE</u> OF THESE PROJECT PARTNERS: ……
What is the nationality of THIS selected partner: ……

PARTNER = the entity of your partner which acts as contract party in the project.

1.12 ***What is the main input of YOUR FIRM:***
(you can select more than one item)

- ☐ Technical knowledge
- ☐ Manpower
- ☐ Finance
- ☐ Market knowledge
- ☐ Distribution channels
- ☐ Other: ……

1.13 ***What is the main input of your PARTNER:***
(you can select more than one item)

- ☐ Technical knowledge
- ☐ Manpower
- ☐ Finance
- ☐ Market knowledge
- ☐ Distribution channels
- ☐ Other: ……

1.14 What is the worldwide sales volume last year YOUR FIRM (in €)

- ☐ < 1 mio €
- ☐ 1 - 25 mio €
- ☐ 25 - 250 mio €
- ☐ 250– 2,5 bln €
- ☐ > 2,5 billion

1.15 Sales volume last year PARTNER (in €)

- ☐ < 1 mio €
- ☐ 1 - 25 mio €
- ☐ 25 - 250 mio €
- ☐ 250– 2,5 bln €
- ☐ > 2,5 billion

1.16 What is YOUR FIRM'S number of employees?

- ☐ 1 - 25
- ☐ 25 - 250
- ☐ 250 - 2.500
- ☐ 2.500 - 25.000
- ☐ > 25.000

1.17 PARTNER's employees?

- ☐ 1 - 25
- ☐ 25 - 250
- ☐ 250 - 2.500
- ☐ 2.500 - 25.000
- ☐ > 25.000

1.18 R&D expenditure of your FIRM (% sales in 2007)

- ☐ 0 - 2%
- ☐ 2 - 5%
- ☐ 5 - 10%
- ☐ 10 - 15%
- ☐ > 15%

1.19 R&D expenditure of your PARTNER (% sales in 2007)

- ☐ 0 - 2%
- ☐ 2 - 5%
- ☐ 5 - 10%
- ☐ 10 - 15%
- ☐ > 15%

1.19 What percentage of your firms' sales is generated by products introduced in the last 3 year?

- ☐ 0 - 2%
- ☐ 2 - 5%
- ☐ 5 - 10%
- ☐ 10 - 15%
- ☐ > 15%

1.20 What is your estimate of the innovativeness of the partner?

Partner's innovativeness

|----------|----------|
NOT INNOVATIVE VERY INNOVATIVE

0 = not innovative, hardly any new products
25 = slightly innovative
50 = considerably innovative
75 = substantially innovative
100 = very innovative, many new products

1.21a What is the <u>importance</u> of the Co-innovation project to your firm? *Importance of the project to <u>US</u> …* |----------|----------| NOT IMPORTANT IMPORTANT ***1.21a <u>Importance</u> of the Co-innovation project to your partner?*** *Importance of the project to the selected <u>PARTNER</u>* |----------|----------| NOT IMPORTANT IMPORTANT	Project is of … 0 = minor importance 25 = some importance 50 = medium important 75 = affects core business 100 = affects core business substantially

2. MARKET

2.1 To what extent is the external market environment ***<u>UNCLEAR OR CONFUSING</u>*** *because it could be understood in more than one way (Ambiguity)?* *Ambiguity in industry* |----------|----------| *VERY CLEAR* *VERY AMBIGUE*	0 = very clear 25 = some confusing elements 50 = market is confusing 75 = market is ambigue 100 = market is very ambigue
2.2 To what extent are elements of the external environment ***<u>INTERCONNECTED OR RELATED TO EACH OTHER</u>*** *in a way that may be difficult to understand or to deal with (Complexity)?* *Complexity in industry* |----------|----------| *SIMPLE* *COMPLEX*	0 = very simple 25 = mostly simple 50 = market is in certain elements simple, but other complex 75 = market is rather complex 100 = market is very complex
2.3. To what extent might elements of the market environment have a fair chance to ***<u>EVOLVE IN AN UNPLEASANT OR UNDESIRABLE WAY</u> (<u>Risk</u>)?*** *Risk in industry* |----------|----------| *LOW RISK* *HIGH RISK*	0 = low risk 25 = rather low risk 50 = some risk 75 = substantial risk 100 = high risk
2.4 To what extent is the external market environment ***<u>UNCERTAIN</u>, BOTH IN TECHNOLOGICAL AND MARKET SENSE,*** *in such a way that it's difficult for managers to judge projects?* *Uncertainty in industry* |----------|----------| *LOW* *HIGH*	0 = low uncertainty 25 = rather low uncertainty 50 = some uncertain elements, some are clear 75 = substantial uncertainty 100 = high uncertainty

2.5 How important is technology in your industry? *Technological importance of industry* |----------|----------| NOT IMPORTANT IMPORTANT	0 = technology is hardly important 25 = … of some importance 50 = … important 75 = … a major key success factor 100 = … the only key success factor
2.6 What is the lifecycle of the MARKET of your project? *Life cycle phase of MARKET* |----------|----------| OLD (DECLINE) YOUNG (EMERGING)	0 = decline 25 = mature, saturated 50 = substantial 75 = growing 100 = emerging
2.7 How fast are external conditions changing of the Co-innovation -project? *External turbulence* |----------|----------| NO CHANGE FAST CHANGE	0 = no change at all 25 = some change 50 = considerable change 75 = sometimes some elements of some 'external turbulence' 100 = very fast change: we can speak of 'external turbulence'
2.8 How concentrated are the sources of expertise in the industries which are relevant to the project? *Knowledge concentration in industry* |----------|----------| WIDELY DISPERSED CONCENTRATED	0 = widely dispersed 25 = dispersed to a certain extent 50 = sometimes dispersed, sometimes concentrated 75 = concentrated 100 = very concentrated

3. STRATEGY

3.1a How important are <u>Strategic & Market</u> motives to start the Project for your FIRM? ***Our** Strategy & Market motives* |----------|----------| NOT IMPORTANT IMPORTANT ***3.1b How important are <u>Strategic & Market</u> Motives to start the Project for your PARTNER?*** ***Partners** Strategy & Market motives* |----------|----------| NOT IMPORTANT IMPORTANT	Importance: 0 = hardly important 25 = of some importance 50 = important 75 = a major key success factor 100 = the only key success factor **Strategy & Market motives are e.g**: – Faster market introduction, Increase market power, develop new markets, co-opt or meet competition, deal with government, faster sufficient market scale of a new product – restructure activities, reduce market uncertainty, set standards

3.2a How important are Technological Motives to start the Project for your firm? ***Our** Organizational & Technological motives* |----------|----------| NOT IMPORTANT IMPORTANT ***3.2b How important are Technological Motives to start the Project for your partner?*** ***Partners** Organizational & Technological motives* |----------|----------| NOT IMPORTANT IMPORTANT	Importance: 0 = hardly important 25 = of some importance 50 = important 75 = a major key success factor 100 = the only key success factor **Technological motives are e.g:** – increase R&D output, more organizational learning, get access to or develop technology get access to or develop competences, get access to or develop facilities. – Less technological risks, reduce organizational uncertainty
3.3a How important are Financial Motives to start the project for your firm? ***Our** Financial motives* |----------|----------| NOT IMPORTANT IMPORTANT ***3.3b How important are Financial Motives to start the project for your partner?*** ***Partners** Financial motives* |----------|----------| NOT IMPORTANT IMPORTANT	**Financial motives are e.g:** – Share development costs, investment opportunities, get access to financial resources, capture knowledge spillovers, exploit financial synergies – cost saving, subsidies,
3.4 To what extent are the <u>strategies</u> of your firm and the partner <u>compatible</u>? *Our strategy and partner's strategy **…*** |----------|----------| MISMATCH: CONFLICTS PERFECT MATCH: SYNERGY	Our strategy and partner's strategy… 0 = don't match: might cause conflicts or be competitive 25 = might conflict at certain areas 50 = no harm, no synergy 75 = enforce each other slightly 100 = enforce each other strongly
3.5a How fast can your firm respond to external variations? ***Our** organizational flexibility* |----------|----------| SLOW FAST ***3.5b How fast can your partners' organization respond to external variations?*** ***Partners'** organizational flexibility* |----------|----------| SLOW FAST	0 = very slow 25 = slow 50 = average 75 = rather fast 100 = very fast

3.6a How fast can your management respond to external variations? ***Our*** *managerial flexibility* |----------|----------| SLOW FAST ***3.6b How fast can your partners' management respond to external variations***? ***Partners'*** *managerial flexibility* |----------|----------| SLOW FAST	0 = very low 25 = low 50 = average 75 = rather high 100 = very high
3.7a How many times are you changing the strategic priorities IN GENERAL? ***Our*** *change of strategic priorities* |----------|----------| *HARDLY EVER* *FREQUENTLY* ***3.7b How many times is your partner changing the strategic priorities IN GENERAL?*** ***Partners'*** *change of strategic priorities* |----------|----------| *HARDLY EVER* *FREQUENTLY*	0 = hardly ever (> 5 years) 25 = sometimes 50 = every 3 – 5 years 75 = 100 = frequently (< 2 years)

4. ORGANIZATION

4.1. How do you consider the <u>initial conditions</u> of your project? *Initial conditions* |----------|----------| UNFAVORABLE FAVORABLE	0 = unfavorable 25 = slightly unfavorable 50 = neutral or unknown 75 = slightly favorable 100 = very favorable
4.2a. What is the <u>role</u> your firm plays in its OTHER partnerships? *Our role in OTHER partnerships* |----------|----------| MARGINAL CENTRAL ***4.2b. What is the <u>role</u> your partner plays in its OTHER partnerships?*** *Partner's role in OTHER partnerships* |----------|----------| MARGINAL CENTRAL	0 = plays usually a marginal role 25 = plays sometimes a marginal role 50 = neutral or unknown 75 = plays sometimes a central role 100 = plays usually a central role

4.3a In <u>how many OTHER partnerships</u> is your firm involved? ***Our** nr of OTHER partnerships* |----------|----------| HARDLY ANY MANY ***4.3b In <u>how many OTHER partnerships</u> is your partner involved?*** *Nr of **partner** OTHER partnerships* |----------|----------| HARDLY ANY MANY	0 = hardly any relations 25 = a few relations 50 = neutral or unknown 75 = many relations 100 = very many relations
4.4a How much <u>coordination is necessary</u> in the project according to your opinion? **Our** *coordination need* |----------|----------| WEAK STRONG ***4.4b How much <u>coordination is necessary</u> in the Project according to your partners' opinion?*** **Partners'** *coordination need* |----------|----------| WEAK STRONG	0 = hardly any coordination needed 25 = on certain aspects some coordination is needed 50 = neutral or unknown 75 = most activities should be coordinated 100 = all activities should be coordinated intensively
4.5 We have the same opinion regarding the <u>governance structure</u> of the projects as our partner … *Desired governance structure* |----------|----------| DIFFERENT SAME	0 = we still disagree on the governance structure 25 = on certain aspect we agree, on others we disagree 50 = neutral or unknown 75 = only on minor aspects we disagree 100 = we fully agree
4.6 Which party is controlling the <u>decision making</u> in the Co-innovation Project ? Control over *decision making* |----------|----------| CONTROLLED BY ONE PARTNER BY ALL	0 = in general, decision making is dominated by a partner 25 = on specific items, decision making is dominated by a partner, on other items by the others 50 = control over decision making unclear, 75 = only on a few specific items decision making is dominated by a partner 100 = all partners control the project equally

4.7a How important is to agree upon the <u>details</u> of an project contract in advance for you? ***We** want agreement on details IN ADVANCE* |----------|----------| NOT IMPORTANT IMPORTANT ***4.7b How important is to agree upon the <u>details</u> of an project contract in advance for your partner?*** ***Partner** wants agreement on details IN ADVANCE* |----------|----------| NOT IMPORTANT IMPORTANT	0 = not necessary 25 = only necessary at specific cases 50 = neutral or unknown 75 = important in certain cases 100 = very important
4.8 To which extent are the relation with your partner (in)formal? *a. On <u>Strategic</u> issues, the relations with our partner are…* |----------|----------| FORMAL INFORMAL *b. On <u>Marketing</u> issues, the relations are…* |----------|----------| FORMAL INFORMAL *c. On <u>Financial</u> issues, the relations are…* |----------|----------| FORMAL INFORMAL *d. On <u>R&D issues</u>, the relations are…* |----------|----------| FORMAL INFORMAL *e. On <u>Project-management</u> issues, the relations are…* |----------|----------| FORMAL INFORMAL	0 = mostly attention to formal processes 25 = formal processes prevail over informal 50 = equal attention to formal and informal processes 75 = informal processes prevail over formal 100 = the informal processes prevail
4.9a How important is it for you to agree upon a <u>formal contract</u> to commit your partner? ***Our** attitude towards a formal contract…* |----------|----------| NOT IMPORTANT IMPORTANT ***4.9b How important is it for your partner to agree upon a <u>formal contract</u> to commit you?*** ***Partner's** attitude formal contract …* |----------|----------| NOT IMPORTANT IMPORTANT	0 = an informal agreement will be sufficient 25 = some elements should be formalized 50 = neutral or unknown 75 = most elements should be formalized 100 = it's necessary to formalize the project contract

4.10a How new are the <u>competences</u> of our project partner for you? ***Partners'*** *Competences* |----------|----------| NOT NEW TO US NEW ***4.10b How new are your competences for your partner***? ***Our*** *competences* |----------|----------| NOT NEW TO PARTNER NEW	0 = not new 25 = some new elements 50 = neutral or unknown 75 = new to a large extent 100 = completely new to us
4.11 Which party learns most? *Learning balance* |----------|----------| THEY LEARN FROM US WE LEARN FROM THEM	0 = the partners learn only from us 25 = the partners learn more from us than we from them 50 = we learn from each other 75 = we learn more from them than they from us 100 = we learn form the partners
4.12a How easy or difficult can your <u>contribution</u> to the project be <u>replaced</u> by your partner? ***Partner*** *can replace* |----------|----------| EASY *DIFFICULT* ***4.12b How easy or difficult can your partners <u>contribution</u> to the project be <u>replaced</u> by you?*** ***We*** *can replace* |----------|----------| EASY *DIFFICULT*	0 = can be replaced easily 25 = can be replaced after some investments 50 = can be replaced after huge investments 75 = can't be replaced at all 100 = they depend on us, like we depend on them

5. RELATIONS

5.1a How do you judge the (project specific) <u>status</u> or reputation of your firm to your project partners? ***Our** reputation* |----------|----------| *UNKNOWN* *WELL KNOWN* ***5.1b How do you judge the (project specific) <u>status</u> or reputation of your partner ?*** ***Partners'** reputation* |----------|----------| *UNKNOWN* *WELL KNOWN*	0 = unknown 25 = rather unknown 50 = neutral 75 = rather wellknown 100 = wellknown
5.2 To what extent does your firm <u>communication style</u> differ from the way of communication of your partners? *Communication style* |----------|----------| DISSIMILAR SIMILAR	0 = very dissimilar 25 = somewhat dissimilar 50 = neutral or unknown 75 = rather similar 100 = very similar
5.3 To what extent does your companies <u>decision making</u> style differ from the way of decision making of your partners? *Decision making style* |----------|----------| DISSIMILAR SIMILAR	0 = very dissimilar 25 = somewhat dissimilar 50 = neutral or unknown 75 = rather similar 100 = very similar
5.4 To what extent does your companies <u>leadership style</u> differ from the way of leadership of your partners? *Leadership style* |----------|----------| DISSIMILAR SIMILAR	0 = very dissimilar 25 = somewhat dissimilar 50 = neutral or unknown 75 = rather similar 100 = very similar
5.5 To what extent does your companies <u>problem solving</u> style differ from the way of problem solving of your partners? *Problem solving style* |----------|----------| DISSIMILAR SIMILAR	0 = very dissimilar 25 = somewhat dissimilar 50 = neutral or unknown 75 = rather similar 100 = very similar

5.6a To what extent can <u>you disclose information</u> in an accurate and timely fashion to your partner? ***Our** openness of communication* |----------|----------| LOW HIGH ***5.6b To what extent can <u>your partner</u> <u>disclose information</u> in an accurate and timely fashion to you?*** ***Partners'** openness of communication* |----------|----------| LOW HIGH	0 = highly restricted in sharing information 25 = discloses some information but mostly reluctant in sharing information 50 = large variations in openness 75 = discloses most information but sometimes reluctant in sharing information 100 = shares all information with us
5.7 To what extent does your partner <u>meet his / her obligations</u>? ***Partner** meets obligations* |----------|----------| NOT MUCH MUCH	0 = partner doesn't meet obligation 25 = … meets sometimes 50 = neutral or unknown 75 = … meest mostly, usually 100 = … meets always
5.8a How often do you <u>give responsibility</u> to your project partners? ***Our** inclination to give responsibility to partner* |----------|----------| SELDOM ALWAYS ***5.8b How often does your partner <u>give responsibility</u> to you?*** ***Partners'** inclination to give responsibility to us* |----------|----------| SELDOM ALWAYS	0 = seldom 25 = sometimes 50 = neutral or unknown 75 = at many occasions 100 = always
5.9a Our partner's willingness and ability to <u>share expertise</u> <u>with us</u> can be rated as… ***Partners'** willingness/ability to share expertise* |----------|----------| LOW HIGH ***5.9b Our willingness and ability to <u>share expertise</u> <u>with them</u> can be rated as…*** ***Our** willingness/ability to share expertise* |----------|----------| LOW HIGH	0 = low 25 = rather low 50 = on some aspects low, on others high 75 = rather high 100 = high

5.10a How much <u>experience</u> with projects does your firm have? ***Our** Experience* |----------|----------| NOT MUCH MUCH ***5.10b How much <u>experience</u> with projects does your partner have?*** ***Partners' Experience*** |----------|----------| NOT MUCH MUCH	0 = no experience yet 25 = some temporal experience with 1-3 narrow defined project projects 50 = multiyear experience with 1-3 projects 75 = multiyear experience with > 3 complex projects 100 = multiyear experience with > 6 complex projects
5.11a How much <u>involvement</u> does your <u>management</u> have in the project? ***Our** management involvement* |----------|----------| LOW HIGH ***5.11b How much <u>involvement</u> does the <u>management</u> of your partner have in the project?*** ***Partner's** management involvement* |----------|----------| LOW HIGH	0 = no support 25 = some distant support 50 = occasional support 75 = substantial involvement 100 = strongly involved
5.12 How do you assess your companies' capabilities to… ***a. Transfer knowledge TO external partners*** |----------|----------| LOW HIGH ***b. Transfer knowledge FROM external partners*** |----------|----------| LOW HIGH ***c. Build and retain relationships WITH external partners*** |----------|----------| LOW HIGH	0 = low capacity - 25 = rather low capacity 50 = neutral 75 = rather high capacity 100 = high capacity

6. PERFORMANCE

6.1 How does the Co-innovation project contribute to the <u>competitive position</u> of your Line of Business? *Attribution to competitive position* |----------|----------| NOT MUCH MUCH	0 = not much 25 = slightly 50 = considerably 75 = substantially 100 = much
6.2 How do you asses the possibility to <u>integrate</u> the project in your business? *Possibility to integrate project* |----------|----------| NOT MUCH MUCH	0 = not possible at all 25 = slightly possible 50 = neutral or unknown 75 = partial fit 100 = perfect fit
6.3 Does the project offer opportunities to reduce your corporate <u>risk or uncertainty</u>? *Reduce risk/uncertainty* |----------|----------| NOT MUCH MUCH	0 = not possible at all 25 = slightly possible 50 = neutral or unknown 75 = some reduction of risk/uncertainty is possible 100 = reduction of risk/uncertainty is absolutely possible
6.4 How does the project contribute to your <u>innovation position?</u> *Attribution to innovation position* |----------|----------| NOT MUCH MUCH	0 = not much 25 = slightly 50 = considerably 75 = substantially 100 = much
6.5 Does the project offer opportunities to access complementary resources? *Access to complementary resources* |----------|----------| NOT MUCH MUCH	0 = not possible at all 25 = slightly possible 50 = neutral or unknown 75 = opportunities on certain areas 100 = many opportunities to access
6.6 Does the project offer opportunities to exploit research synergies? *Exploit research synergies* |----------|----------| NOT MUCH MUCH	0 = not possible at all 25 = slightly possible 50 = neutral or unknown 75 = opportunities on certain areas 100 = many opportunities to exploit
6.7 ***Who receives <u>rights to market</u> or distribute the products?*** *Market benefits* |----------|----------| WE EQUAL PARTNER	

6.8 How are the <u>profits (or losses) allocated</u>?

Sharing of risk and revenue

|----------|----------|

WE EQUAL PARTNER

6.9 Who owns the <u>Intellectual Property</u> of the project?

Ownership of Intellectual Property Rights

|----------|----------|

WE EQUAL PARTNER

6.10 Who invests cash?

Cash spending

|----------|----------|

WE EQUAL PARTNER

6.11 Who invest time?

Time spending

|----------|----------|

WE EQUAL PARTNER

6.12 What happens if more money is needed?

Additional inputs coming from…

|----------|----------|

ONLY FROM US FROM ALL PARTNERS ONLY FROM PARTNER OR OTHERS

6.13 When will the project reach a break even situation? (positive cumulative cash flow)?

Cumulative cash flow (break even in … years)

|----------|----------|----------|----------|

>10y 5y 3y 2y 1y

0 = break even > 10 years
25 = break even in 5 years
50 = break even in 3 years
75 = break even in 2 years
100 = break even within 1 year

6.14 What is at this moment your firm's <u>success rate with your OTHER</u> projects (IN GENERAL)?

***Our** project success rate*

|----------|----------|

LOW HIGH

0 = low success rate
25 = rather low success rate
50 = sometimes succes
75 = rather high success rate
100 = high success rate

6.15 ***What is your expectation of the <u>total revenue growth</u> of the Co-innovation Project in the near future (coming 5 years)?***

Total revenue growth next 5 years (%)

|----------|----------|----------|----------|

<5 % 5-10% 10-15% 15-20% >20%

0 = < 5 %
25 = 5 - 10 %
50 = 10 - 15 %
75 = 15 - 20 %
100 = > 20 %

6.16 What is the project performance of the co-innovation project?

Meeting financial goals

|----------|----------|----------|
0 33% 65% 100%
>100%

Meeting strategic goals

|----------|----------|----------|
0 33% 65% 100%
>100%

Meeting learning goals

|----------|----------|----------|
0 33% 65% 100%
>100%

=

0 = no performance at all
25 = meeting 35% of expectations
50 = meeting 65% of expectations
75 = meeting 100% of expectations
100 = exceeding expectations

THANK YOU VERY MUCH FOR ANSWERING!

PLEASE SEND THE QUESTIONNAIRE TO:

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Vennebroek 12
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APPENDIX B: REFERENCES

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APPENDIX C: RESPONDENTS

Company	Pretest interviews and feedback
Bekaert	J. Sijnave
Brabantia	W. Marques
DSM	Y. Engelen
Fresfield Bruckhaus Deringer	W. V. Angeren – v.d. Elzen
Friesland Foods / TIFN	J. Sikkema
IBM	D.Schiferli,
Indiegroep	W. Soens
Hanze Hogeschool	F.J. de Graaf, M. Carriere
Philips	J. Bell, M. Overwijk. B. Oudman, C. Kuiper, T. Doyle
Purac	R. Zoetemeyer
SBGG	F. Wijbenga
Shell	G. Bol
UMCG	E. Jippes,
Unilever	G. Cross
University of Hasselt	W. Vanhaverbeke
University of Utrecht	T. Poot
WRR	B. Booteboom

Company	Network
Province of Groningen	R. Hoppenbrouwers, J. Janssens
RUG	G. Sanders, M. Pool
Shell	G. Bol
SNN	H. Emmens
TCNN	A. Gielen
TLG	T. Looijenga
UMCG	E. Vermeer

Company	Respondent
Agfa	J. Claes
Akzo	H. Kielstra and A. Luttmer
Alan	J. Abma
ASML	J. Benshop
ATH Astron	A. Van Ardenne[I]
Avebe	M. Guissepin
Barkmeijer	H. Veraart
Batavus	R. Van Regelmortel, R. Beset
Bioclear	J. Krooneman
BZIM	W. Zomers
Ceva	M. Gouda[I], J. Kuipers, R. Kuijpers, R. v. d. Putten
DOMO	A. Groeneveld, F. Fox, E. Van Leusen, B. Klarenbeek, C. Timmer
DSM-Lifesciences	B. Poldermans
DSM-Materials	R. Kirschbaum[I]
Eco Protecta	C. Hartman
Friesland Foods	R. Schoenmaker
Fortis Venturing	K. Vandervelpen[I]
IBBT	N. Verplanck, AdV
IBM	R. Reesen, N. Braat
Innocore	T. Flipsen
Johnson & Johnson	G. Lauwers
Kievit	R. Kirpestein[I], P. Posthouwer, F. Systermans

[I] Also pretest interview

KVE	H. Van Engelen
Leenstra	H. De Jong
NDC	S. Mulder, P. Idema, P. Sijbersma, C. Anceaux, G. Zijlstra. W. Kunst
Nedap	N. Kip
Neopost	F. Bosveld
New Trecious	J. Nelissen
NOM	E. Blansjaar
Oosterhof	R. Rinia
Oranjewoud	H. Tjeersma, A. Wiersma, B. Smulders, G. Bos
Organ Assist	A. V. d. Plaats, G. Rakhorsrt
P2	W. Posthouwer
Paques	E. Van Zessen, P. v. d. Heijden, C. Schulz, W. Anema
Pezy	M. Rijken
Philips Consumer Lifestyle	K. v. d. Wal[1], C. Engel
Philips Medical Systems	A. Leenaarts. W. Crooijmans
Proces	H. Banning
Procter & Gamble	A. Convents
Purac	P. Jansen, J. V. Breugel, E. Bontenbal, D. Visser
Sping	R. Verdonk
Stork	A. Offringa, Van Ingen, M. V. Lankveld
Televic	B. Stubbe
Thales	E. Dontle
TNO-ICT	J. Burgmeijer
Unilever	R. Dirks, T. Koning, E. V. Buren
V.d.Velden	E. Van Buren
Wegener	H. Rimmelzwaan, S. v. d. Hout
Wetsus	G.H. Euverink, C. Buisman
Whirlwind	T. Bakker
Winglove	P. Pekelharing
IJsseltechnologie	R. Slingeland, J. Volker

APPENDIX D: EFFECTS of INDUSTRY and PROJECT DURATION

Complementary to the testing of our hypotheses we will *explore* the different impact on performance in three industrial groups (manufacturing, food and service industries) as well as projects of differing duration (both young and mature). We illustrate some examples in the following.

Our entire dataset consists of 137 aggregated observations, of which 47 were derived from manufacturing, 47 from the food sector, and 43 from service industries. In addition, identified by the median of the year that they began, we divided our database into 59 young projects (i.e. which began 2006 or later), and 78 mature projects (i.e. which began before 2006). Because of the reduced size of these smaller industrial or duration-specific samples, we simplified our models by removing non-significant variables from the analyses in order to deal with a minimum of at least five observations per independent variable, as discussed in Section 5.6 (Hair et al. 2010). In these cases, non-significant variables were removed from further regressions. Furthermore, we simplified our COINN-model; by concentrating on two rather than three performance measures. As a measure of financial performance we took the meeting of financial objectives and as a measure of commercial or technological performance, the relative ownership of IP (partner versus firm). We base our conclusions on these simplified models, which have on average seven observations per variable.[1]

We summarize the regression results of the industries in Tables D.1 and of the projects of differing duration in Table D.2 We show the significant regression results in Table D.3 (regression on with the manufacturing industry), Table D.4 (food industry), Table D.5 (service industries), Table D.5 (young projects), Table D.5 (mature projects), and subsequently discuss the results. We visualize the significant associations in standardized graphs, in which we plot the dependent variables on Y-axes, and the independent variables on X-axes, following the legend in Figure D.1.

[1] In manufacturing, the numbers of observations per variable are for regressions with strategic performance: 7, with learning performance: 6, and with meeting financial objectives: 8. In the food industry, the numbers of observations per variable are for regressions with strategic performance: 5, with learning performance: 6, and with meeting financial objectives: 10. In the service industries, the numbers of observations per variable are for regressions with strategic performance: 11, with learning performance: 5, and with meeting financial objectives: 4. For young projects, the numbers of observations per variable are for regressions with strategic performance: 7, with learning performance: 10 and with meeting financial objectives: 5. For mature projects, the numbers of observations per variable are for regressions with strategic performance: 8, with learning performance: 8 and with meeting financial objectives: 7. The regressions with meeting financial objectives in service industries should be interpreted with caution due to a limited number of observations per variable.

Figure D.1: Legend of performance figures

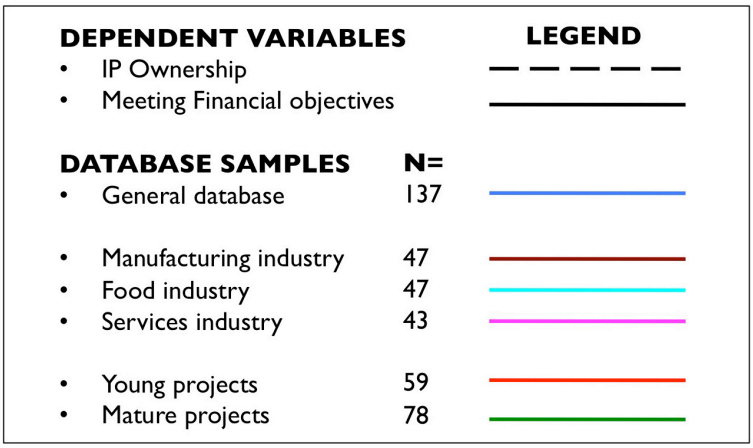

Table D.1: Exploration of effects per industry

	IP ownership	*Meeting financial objectives*
Manufacturing industry	▪ Balanced competences: hill-shaped */° ▪ Firm's management involvement: negative°	▪ Culture fit: positive*** ▪ Number of partners: hill-shaped** ▪ Firm's innovativeness: positive* ▪ Stability: positive***
Food industry	▪ Contract need positive°[2] ▪ Firm's embeddedness: hill-shaped**/* ▪ Partner's embeddedness: U-shaped**/* ▪ Balanced competences: negative° ▪ Firm's importance: negative°[3] ▪ Partner's importance: positive* ▪ Firm's strategic motives: positive**	▪ Trust: hill-shaped* ▪ Technical informality: negative° ▪ Firm's innovativeness: positive°
Service industry	▪ Firm's embeddedness: U-shaped*/° ▪ Partner's embeddedness: hill-shaped**/* ▪ Firm's management involvement: U-shaped° ▪ Firm's importance: negative**/* ▪ Partner's importance: positive*** ▪ Firm's flexibility: positive**	▪ Partner's embeddedness: U-shaped**/* ▪ Coordination need: U-shaped* ▪ Trust: positive* ▪ Technology transfer: positive° ▪ Firm's management involvement: negative° ▪ Project life cycle: hill-shaped* ▪ Number of partners: hill-shaped°

Notes: ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

[2] In Model 5.
[3] In Model 4.

Table D.2: Exploration of effects of project duration

	IP ownership	*Meeting financial objectives*
Young	▪ Firm's management involvement: hill-shaped° ▪ Technical informality: hill-shaped° ▪ Number of partners: positive** ▪ Partner's importance: positive*	▪ Contract need U-shaped**/* ▪ Partner's embeddedness: U-shaped° ▪ Balanced competences: hill-shaped*/° ▪ Firm's management involvement: U-shaped */° ▪ Partner's management involvement: positive* ▪ Commercial informality: hill-shaped* ▪ Firm's innovativeness: positive** ▪ Stability: positive*
Mature	▪ Firm's embeddedness: positive** ▪ Partner's embeddedness: negative** ▪ Culture fit: hill-shaped° ▪ Size difference (employees): negative*** ▪ Firm's sales per employee: negative* ▪ Partner's sales per employee: negative** ▪ Firm's flexibility: positive** ▪ Firm's importance: negative* ▪ Partner's importance: positive***	▪ Contract need U-shaped* ▪ Partner's embeddedness: U-shaped**/° ▪ Coordination need: U-shaped° ▪ Trust: hill-shaped** ▪ Technical informality: hill-shaped **/* ▪ Project life cycle: hill-shaped° ▪ Number of partners: hill-shaped° ▪ Firm's innovativeness: positive* ▪ Stability: positive***

Notes: ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

Table D.3: Regressions with the manufacturing industry

IP OWNERSHIP, MANUFACTURING INDUSTRY						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	NR. OF PARTNERS	0.01	0.01	0.005	0.01	0.011
		(1.09)	(0.59)	(0.47)	(0.67)	(0.86)
	SIZE DIFFERENCE	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***
	(Employment)	(-5.50)	(-5.61)	(-5.44)	(-5.41)	(-4.22)
	FIRM'S STRAT. MOTIVES	-0.12	-0.26	-0.25	-0.26	-0.28
		(-0.48)	(-0.99)	(-0.91)	(-0.93)	(-0.93)
Org. var	BALANCED COMPETENCES		0.46°	1.50	2.28*	2.21°
			(1.96)	(1.35)	(2.20)	(1.92)
	BALANCED COMPETENCES			-0.0789	-0.133	-0.13
	(Quadratic)			(-0.97)	(-1.85)	(-1.60)
Rel var	FIRM'S MANAGEMENT INVOLVEMENT				-0.32°	0.61
					(-1.72)	(0.45)
	FIRM'S MANAGEMENT INVOLVEMENT					-0.07
	(Quadratic)					(-0.63)
	_cons	5.22*	3.16	-0.19	-0.28	-2.31
		(2.82)	(1.53)	(-0.04)	(-0.07)	(-0.45)
	N	41	41	41	41	41
	R-sq	17.7%	22.7%	23.5%	27.4%	28.4%
	adj. R-sq	11.0%	14.1%	12.6%	14.5%	13.2%

MEETING FINANCIAL OBJECTIVES, MANUFACTURING INDUSTRY						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	NR. OF PARTNERS	3.16**	3.16**	3.16**	3.29**	3.29**
		(2.90)	(2.90)	(2.90)	(2.99)	(2.99)
	NR. OF PARTNERS	-0.30**	-0.30**	-0.30**	-0.31**	-0.31**
	(Quadratic)	(-3.25)	(-3.25)	(-3.25)	(-3.34)	(-3.34)
	FIRM'S INNOVATIVENESS	0.09*	0.09*	0.09*	0.06	0.06
		(2.19)	(2.19)	(2.19)	(1.48)	(1.48)
	STABILITY	0.596***	0.596***	0.596***	0.637***	0.637***
		(4.23)	(4.23)	(4.23)	(4.93)	(4.93)
Relational var.	CULTURAL FIT				0.353***	0.353***
					(4.55)	(4.55)
	_cons	-3.95°	-3.95°	-3.95°	-5.82*	-5.82*
		(-1.70)	(-1.70)	(-1.70)	(-2.30)	(-2.30)
	N	41	41	41	41	41
	R-sq	47.4%	47.4%	47.4%	56.1%	56.1%
	adj. R-sq	41.6%	41.6%	41.6%	49.9%	49.9%

Notes: t statistics in parentheses, ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

Table D.4: Regressions with the food industry

IP OWNERSHIP, FOOD INDUSTRY						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	FIRM'S IMPORTANCE	-0.24	-0.24	-0.24	-0.32*	-0.18
		(-1.19)	(-1.19)	(-1.19)	(-2.28)	(-1.51)
	PARTNER IMPORTANCE	0.31°	0.31°	0.31°	0.31*	0.42*
		(2.11)	(2.11)	(2.11)	(2.40)	(2.74)
	FIRM'S STRATEGIC MOTIVES	0.29	0.29	0.29	0.33*	0.40**
		(1.38)	(1.38)	(1.38)	(2.20)	(3.57)
Organizational variables	CONTRACT NEED				0.22	0.30°
					(1.45)	(1.90)
	FIRM'S EMBEDDEDNESS				0.20	3.55**
					(0.61)	(3.28)
	FIRM'S EMBEDDEDNESS (Quadratic)					-0.28*
						(-2.88)
	PARTNER'S EMBEDDEDNESS				-0.38**	-1.60**
					(-3.54)	(-3.46)
	PARTNER'S EMBEDDEDNESS (Quadratic)					0.11*
						(2.57)
	BALANCED COMPETENCES (Quadratic)					-0.02
						(-1.93)
	_cons	1.23	1.23	1.23	0.96	-6.70°
		(0.77)	(0.77)	(0.77)	(0.38)	(-1.84)
	N	50	50	50	50	50
	R-sq	18.7%	18.7%	18.7%	32.8%	49.7%
	adj. R-sq	13.4%	13.4%	13.4%	23.4%	38.3%

MEETING FINANCIAL OBJECTIVES, FOOD INDUSTRY (continued)						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	FIRM'S INNOVATIVENESS	0.16°	0.16°	0.16°	0.12	0.13°
		(2.10)	(2.10)	(2.10)	(1.63)	(1.96)
Relational variables	TRUST				0.32	3.29*
					(1.21)	(2.53)
	TRUST (Quadratic)					-0.23*
						(-2.31)
	TECHNICAL INFORMALITY				-0.31*	-0.29°
					(-2.18)	(-1.94)
	_cons	4.33***	4.33***	4.33**	4.32*	-4.79
		(5.15)	(5.15)	(5.15)	(2.34)	(-1.09)
	N	50	50	50	50	50
	R-sq	15.0%	15.0%	15.0%	23.4%	29.9%
	adj. R-sq	13.2%	13.2%	13.2%	18.4%	23.6%

Notes: t statistics in parentheses, ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

Table D.5: Regressions with services industries

IP OWNERSHIP, SERVICES INDUSTRY						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	FIRM'S IMPORTANCE	-0.55*	-0.48*	-0.47**	-0.52*	-0.55**
		(-2.85)	(-2.33)	(-3.07)	(-2.78)	(-3.09)
	PARTNER IMPORTANCE	0.57**	0.50**	0.53***	0.56***	0.53***
		(3.48)	(3.10)	(4.22)	(5.05)	(5.23)
	FIRM'S FLEXIBILITY	0.68**	0.60**	0.52**	0.49**	0.47**
		(3.49)	(3.77)	(3.45)	(3.92)	(3.56)
Organizational variables	FIRM'S EMBEDDEDNESS		0.44*	-0.98	-1.53*	-1.14
			(2.78)	(-1.66)	(-2.21)	(-1.80)
	FIRM'S EMBEDDEDNESS			0.13*	0.17*	0.14*
	(Quadratic)			(2.31)	(2.64)	(2.42)
	PARTNER'S EMBEDDEDNESS		-0.22	0.75	0.92°	1.01*
			(-1.42)	(1.40)	(1.88)	(2.32)
	PARTNER'S EMBEDDEDNESS			-0.09*	-0.10*	-0.10**
	(Quadratic)			(-2.16)	(-2.60)	(-3.11)
Relational variables	FIRM'S MANAGEMENT INVOLVEMENT				0.17°	-0.71
					(2.03)	(-1.62)
	FIRM'S MANAGEMENT INVOLVEMENT					0.08°
	(Quadratic)					(1.93)
	_cons	0.02	-1.40	0.15	0.50	0.74
		(0.02)	(-1.55)	(0.17)	(0.39)	(0.66)
	N	46	46	46	46	46
	R-sq	39.1%	46.8%	51.0%	53.0%	56.4%
		34.7%	40.2%	41.9%	42.8%	45.5%

to be continued on the next page

MEETING FINANCIAL OBJECTIVES, SERVICES INDUSTRY (continued)						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	PROJECT LIFE CYCLE	2.23***	2.14**	1.84**	1.28*	1.46*
		(4.69)	(3.75)	(3.43)	(2.42)	(2.89)
	PROJECT LIFE CYCLE	-0.22**	-0.21*	-0.18**	-0.13°	-0.15*
	(Quadratic)	(-3.49)	(-2.91)	(-3.12)	(-2.12)	(-2.83)
	NR. OF PARTNERS	2.62*	2.75*	2.26*	0.94	1.43°
		(2.62)	(2.65)	(2.52)	(1.11)	(1.75)
	NR. OF PARTNERS	-0.250*	-0.255*	-0.206°	-0.080	-0.13°
	(Quadratic)	(-2.21)	(-2.15)	(-2.11)	(-0.96)	(-1.65)
Organizational variables	COORDINATION NEED		-0.18	-1.04°	-1.24*	-1.31*
			(-1.75)	(-2.11)	(-2.21)	(-2.56)
	COORDINATION NEED			0.09*	0.10°	0.11*
	(Quadratic)			(2.21)	(1.93)	(2.59)
	PARTNER'S EMBEDDEDNESS		0.12	-0.59	-1.31**	-1.26*
			(1.20)	(-1.20)	(-3.65)	(-2.90)
	PARTNER'S EMBEDDEDNESS			0.081	0.14**	0.13**
	(Quadratic)			(1.47)	(3.72)	(3.05)
Relational variables	TRUST				0.26	0.42*
					-1.33	-2.45
	TRANSFER OF TECHNOLOGY				0.47°	0.43°
					(1.88)	(1.94)
	FIRM'S MANAGEMENT INVOLVEMENT					-0.03*
	(Quadratic)					(-2.24)
	_cons	-4.67*	-4.37°	-0.73	-0.10	-0.60
		(-2.33)	(-1.92)	(-0.30)	(-0.05)	(-0.35)
	N	46	46	46	46	46
	R-sq	35.8%	38.7%	48.0%	60.3%	66.9%
	adj. R-sq	29.5%	29.3%	36.8%	48.9%	56.2%

Notes: t statistics in parentheses, ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

Table D.6: Regressions with young projects

IP OWNERSHIP, YOUNG PROJECTS						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	NR OF PARTNERS	0.023**	0.023**	0.023**	0.025*	0.027*
		(2.78)	(2.78)	(2.78)	(2.08)	(2.57)
	PARTNER IMPORTANCE	0.27*	0.27*	0.27*	0.25*	0.18
		(2.37)	(2.37)	(2.37)	(2.20)	(1.46)
Relational variables	FIRM'S MANAGEMENT INVOLVEMENT				0.061	0.93°
					(0.69)	(2.03)
	FIRM'S MANAGEMENT INVOLVEMENT (Quadratic)					-0.08°
						(-1.68)
	TECHNICAL INFORMALITY				0.07	0.75°
	TECHNICAL INFORMALITY (Quadratic)					-0.06
						(-1.69)
	_cons	1.45°	1.45°	1.45°	0.66	-1.87
		(1.78)	(1.78)	(1.78)	(0.51)	(-1.63)
	N	59	59	59	59	59
	R-sq	11.3%	11.3%	11.3%	11.9%	20.1%
	adj. R-sq	8.2%	8.2%	8.2%	5.4%	10.8%
MEETING FINANCIAL OBJECTIVES, YOUNG PROJECTS						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	FIRM'S INNOVATIVENESS	0.17**	0.17**	0.16*	0.24***	0.24***
		(3.23)	(3.06)	(2.66)	(3.70)	(3.78)
	STABILITY	0.375	0.378*	0.431*	0.363*	0.28
		(1.94)	(2.17)	(2.22)	(2.06)	(1.49)
Organizational variables	CONTRACT NEED		-0.36°	-1.22°	-1.33*	-1.63**
			(-1.88)	(-1.91)	(-2.20)	(-3.06)
	CONTRACT NEED (Quadratic)			0.08	0.09°	0.10*
				(1.53)	(1.72)	(2.31)
	PARTNER'S EMBEDDEDNESS		0.13	1.15*	1.10°	1.07°
			(0.95)	(2.05)	(1.73)	(1.82)
	PARTNER'S EMBEDDEDNESS (Quadratic)			-0.09	-0.09	-0.10°
				(-1.62)	(-1.52)	(-1.71)
	BALANCED COMPETENCES		0.25	1.43°	2.31*	2.32*
			(1.32)	(1.86)	(2.26)	(2.12)
	BALANCED COMPETENCES (Quadratic)			-0.09	-0.17*	-0.16°
				(-1.47)	(-2.18)	(-1.89)

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	MEETING FINANCIAL OBJECTIVES, YOUNG PROJECTS (continued)					
Relational variables	FIRM'S MANAGEMENT INVOLVEMENT				-0.36*	-1.31*
					(-2.11)	(-2.60)
	FIRM'S MANAGEMENT INVOLVEMENT					0.08°
	(Quadratic)					(1.80)
	PARTNER'S MANAGEMENT INVOLVEMENT				0.23°	0.26*
					(1.76)	(2.12)
	COMMERCIAL INFORMALITY				0.30°	1.31*
					(1.69)	(2.64)
	COMMERCIAL INFORMALITY					-0.11*
	(Quadratic)					(-2.28)
	_cons	1.87	1.71	-2.33	-5.20	-3.13
		(1.64)	(0.79)	(-0.74)	(-1.41)	(-1.05)
	N	59	59	59	59	59
	R-sq	23.6%	31.5%	34.7%	44.0%	51.4%
	adj. R-sq	20.9%	25.0%	24.3%	30.9%	37.4%

Notes: t statistics in parentheses, ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

Table D.7: Regressions with mature projects

	IP OWNERSHIP, MATURE PROJECTS					
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	FIRM'S SALES PER EMPLOYEE	-0.31*	-0.45***	-0.45***	-0.42**	-0.34*
		(-2.63)	(-4.59)	(-4.59)	(-3.54)	(-2.60)
	EMPLOYMENT DIFFERENCE	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***
		(-10.81)	(-7.21)	(-7.21)	(-6.85)	(-7.40)
	FIRM'S IMPORTANCE	-0.50**	-0.39**	-0.39**	-0.39**	-0.40**
		(-3.32)	(-2.78)	(-2.78)	(-2.88)	(-3.01)
	PARTNER IMPORTANCE	0.46***	0.42***	0.42***	0.42***	0.44***
		(3.67)	(3.72)	(3.72)	(3.75)	(4.10)
	FIRM'S FLEXIBILITY	0.45**	0.39**	0.39**	0.39***	0.40***
		(3.52)	(3.49)	(3.49)	(3.62)	(3.75)
Organizational variables	FIRM'S EMBEDDEDNESS		0.37**	0.37**	0.39**	0.32**
			(3.06)	(3.06)	(3.16)	(2.75)
	PARTNER'S EMBEDDEDNESS		-0.35**	-0.35**	-0.33**	-0.36**
			(-3.25)	(-3.25)	(-2.83)	(-3.02)
Relational variables	CULTURAL FIT					-0.08°
	(Quadratic)					(-1.87)
	_cons	2.12	1.63	1.63	1.72	0.91
		(1.71)	(1.04)	(1.04)	(1.08)	(0.63)
	N	78	78	78	78	78
	R-sq	36.8%	46.9%	46.9%	47.4%	49.5%
	adj. R-sq	32.4%	41.6%	41.6%	41.3%	42.8%

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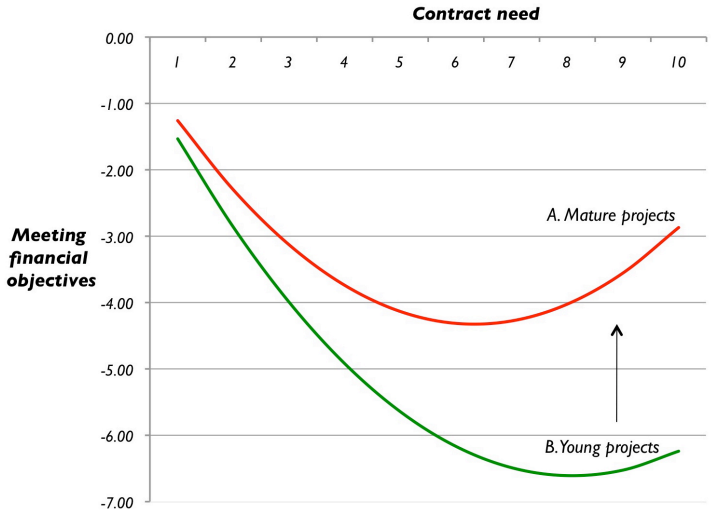
MEETING FINANCIAL OBJECTIVES, MATURE PROJECTS (continued)						
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	PROJECT LIFE CYCLE	1.16**	1.14*	0.88°		
		(2.76)	(2.62)	(1.92)		
	PROJECT LIFE CYCLE	-0.09*	-0.10*	-0.07°		
		(-2.43)	(-2.47)	(-1.87)		
	NR. OF PARTNERS	2.01°	1.75°	1.58°		
		(1.92)	(1.79)	(1.65)		
	NR. OF PARTNERS	-0.23*	-0.19	-0.17		
	(Quadratic)	(-2.23)	(-1.91)	(-1.75)		
	FIRM'S INNOVATIVENESS	0.09*	0.08°	0.09°	0.10*	0.11*
		(2.03)	(1.69)	(2.03)	(2.19)	(2.37)
	STABILITY	0.29*	0.36***	0.37***	0.40**	0.48***
		(2.44)	(3.66)	(3.78)	(3.27)	(4.29)
Organizational variables	CONTRACT NEED		0.15	-0.06	-0.31	-1.37*
			(1.16)	(-0.09)	(-0.41)	(-2.25)
	CONTRACT NEED			0.02	0.04	0.11*
	(Quadratic)			(0.31)	(0.62)	(2.09)
	PARTNER'S EMBEDDEDNESS		0.38**	-0.15	-0.41	-0.89°
			(3.57)	(-0.31)	(-0.76)	(-1.93)
	PARTNER'S EMBEDDEDNESS			0.06	0.09°	0.13**
	(Quadratic)			(1.43)	(1.76)	(3.05)
	COORDINATION NEED		-0.18°	-1.16*	-1.28*	-1.04°
			(-1.69)	(-2.21)	(-2.35)	(-1.97)
	COORDINATION NEED			0.09°	0.10°	0.08
	(Quadratic)			(1.86)	(1.84)	(1.61)
Relational variables	TRUST				0.22	2.71**
					(1.27)	(3.34)
	TRUST					-0.18**
	(Quadratic)					(-2.94)
	TECHNICAL INFORMALITY				0.11	1.30*
					(0.49)	(2.39)
	TECHNICAL INFORMALITY					-0.137**
	(Quadratic)					(-2.90)
	_cons	-2.93	-4.41*	-0.47	3.48	-1.91
		(-1.09)	(-2.19)	(-0.19)	-1.74	(-1.33)
	N	78	78	78	78	78
	R-sq	20.0%	30.4%	38.9%	36.2%	48.6%
	adj. R-sq	13.2%	21.2%	27.6%	26.7%	39.2%

Notes: t statistics in parentheses, ° p<0.1, p<0.05, ** p<0.01, and *** p<0.001.*

Contract need, an obligation to agree upon details and a formal contract in advance, is negatively associated with meeting financial objectives. In the initial phase of innovation, a certain space for creativity and flexibility in order to cope with unforeseen circumstances is especially necessary with the added consequence that meeting financial objectives will be affected negatively particularly in young projects (Figure D.2, curve B). Although less prominent, the effect in mature projects remains negative (curve A). The optimum *contract need* is at a minimal level. Increasing values of *contract need* cause deterioration in

meeting financial objectives, although above an inflection point of 6.3 (in mature projects) or 8.1 (in young projects), the negative effect is reduced.

Figure D.2: Differences of contract need across project age



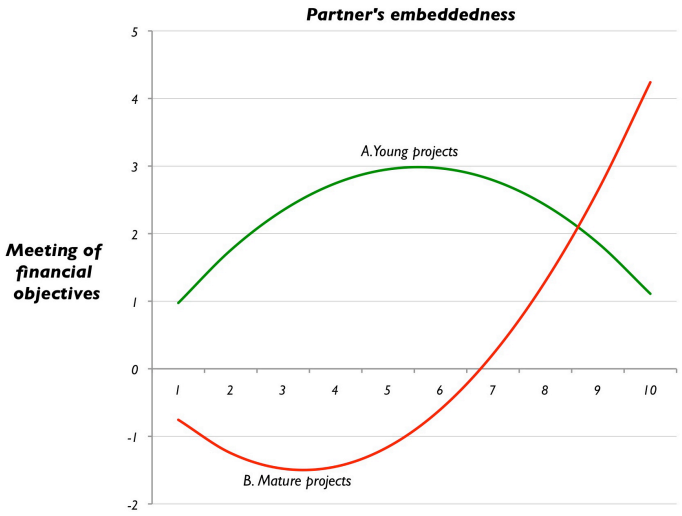
Especially for young companies, cooperating with others is essential (Shan et al., 1994; Baum et al., 2000). More embeddedness of partner's implies more novelty value,[4] due to the fact that the partner has more network relationships, or more co-innovation experience. This learning effect is most beneficial when alliance activities are complex and uncertain- e.g., in the initial phase of innovation (Sampson, 2005) or when companies are inexperienced in young cooperation, when there is much to be gained from the alliance partners. The cumulative benefits of partner's embeddedness tend to decrease after a certain level (see Figure D.3, curve A). In this case, a company may exceed its capacity in handling the huge amount of information to be derived from the partner's network relationships, or the information may start to become out-dated. At the same time, the partner's network relationships will not only transfer knowledge *to*, but also start to learn *from* the co-innovation alliance as a co-innovation alliance can be considered to be a "race to learn" (see Section 4.3.3).

In mature projects, the *partner's embeddedness* has a negative impact on meeting financial objectives of the focal firm due to the fact that the effect of potential IP-leakage exceeds the novelty value of the partner's network relationships (Figure D.3, curve B). In mature projects, a positive net balance of

[4] Sometimes, the term 'novelty value' may have a negative connotation, referring to a temporary or fashionable newness. We use this term in the positive sense as it is understood in the professional literature.

transfer of knowledge transfer *to and from* the co-innovation alliance only can be reached if a huge variety of network resources of the partner offer sufficient additional novelty value.

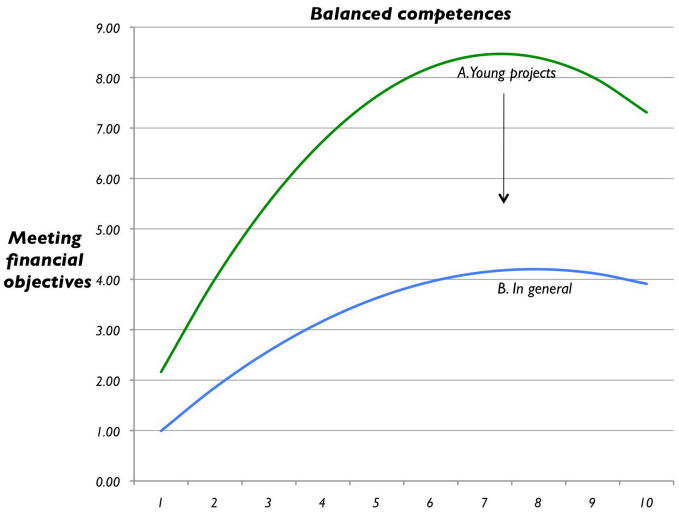
Figure D.3: Differences of partner's embeddedness across project age



Balanced competences, a situation in which the competences of the co-innovation alliance partners are both unique and durable, have a different impact on the meeting of financial objectives. Young projects usually benefit financially from *balanced competences*, but at a diminishing rate (see Figure D.4, curve A). Above an inflection point of 7.3, the negative curvilinear effect surpasses the positive linear effect. In general, we observed a hill-shaped, though limited, association (curve B).

To a certain extent, *balanced competences* are beneficial; however, too many *balanced competences* may be dysfunctional. In this case, companies become over dependent on their co-innovation partners, resulting in a counter-productive or sub-optimal cooperation in which the other partners might supply more promising or innovative solutions, or the cooperation may lead to insufficient flexibility when dealing with changing market circumstances.

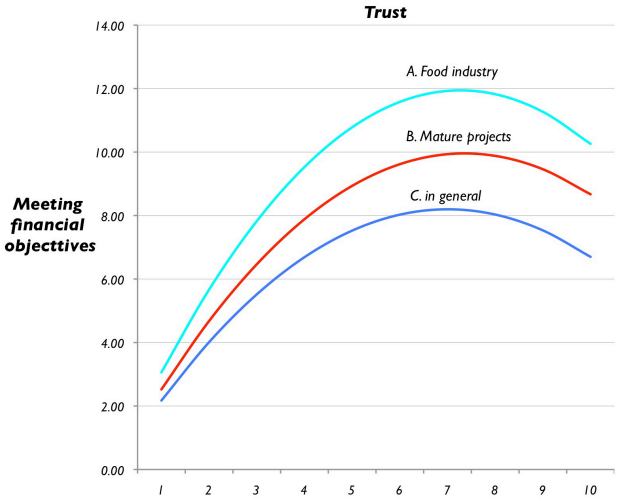
Figure D.4: Differences of balanced competences across project age



We defined '*trust*' as the degree of openness between the responding company and its partners, the extent to which obligations are met by the partner, and the willingness and ability to share the expertise of the company and its partner. *Trust* to a certain level is beneficial, particularly in the food industry (see Figure D.5 (curve A), in mature projects (curve B). Above inflection points of 7.4 (mature projects and food industry), however, too much *trust* will cause deterioration in the financial results.

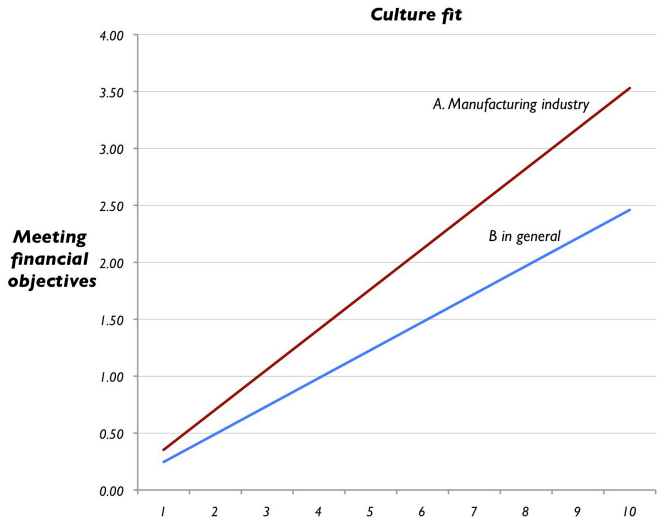
Due to strict safety regulations in the food industry, meeting obligations by the partner openness are vital and willingness and ability to share the expertise are essential to the cooperation. The importance of trust in meeting the financial objectives in mature projects can be explained by the fact that trust between the alliance partners cannot be built overnight; it will grow gradually by having positive joint experiences (Jennings et al., 2000; Park and Ungson, 2001). At the same time, too much trust has also negative effects: it can lead to complacency, an acceptance of less-than satisfactory outcomes from a relationship, less information exchange between partners, or unnecessary obligations (Gargiulo and Ertug, 2006).

Figure D.5: Different effects of trust and performance



Especially in the manufacturing industry, a *culture fi*t has a positive impact on meeting financial objectives (Figure D.6, curve A). The more the partners resemble one another in terms of communication style, decision-making, leadership, and problem-solving style, the better the financial results. Cultural similarity increases stability and facilitates easy problem solving. Similarity of cultural values reduces misunderstanding or difficulty in the exchange of knowledge between the partners (Lyles and Salk, 1996; Lin and Germain, 1998; Demirbag et al., 2007).

Figure D.6: Differences of culture fit across industry



Especially in mature projects and in the manufacturing industry, *technical informality*) is hill-shaped when associated with meeting financial objectives (see Figures D.7a and D.7b, curves A, both with inflection points of 4.8). In contrast with manufacturing industry, *technical informality* in the food industry, is negative linearly related when meeting financial objectives (curve Figure D.7b, curve B). Here, any informality regarding R&D and project management has a negative financial impact due to strict food safety regulations.

Figure D.7a: Differences of technical informality across project age

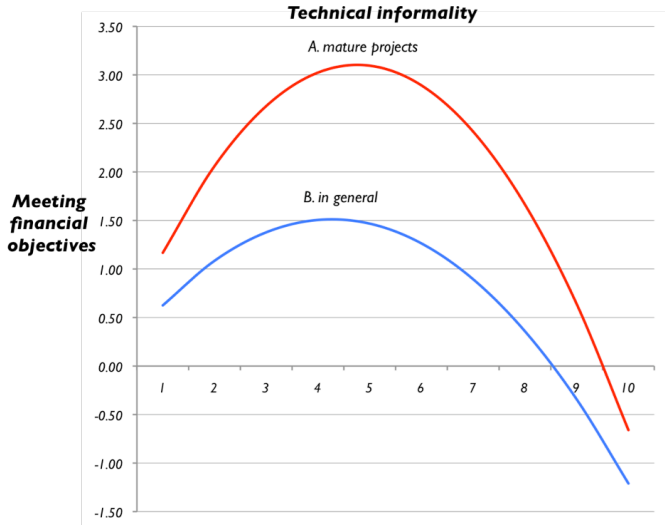
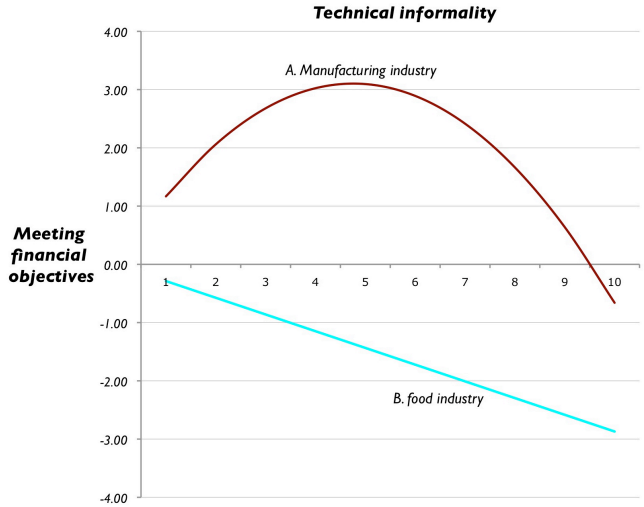
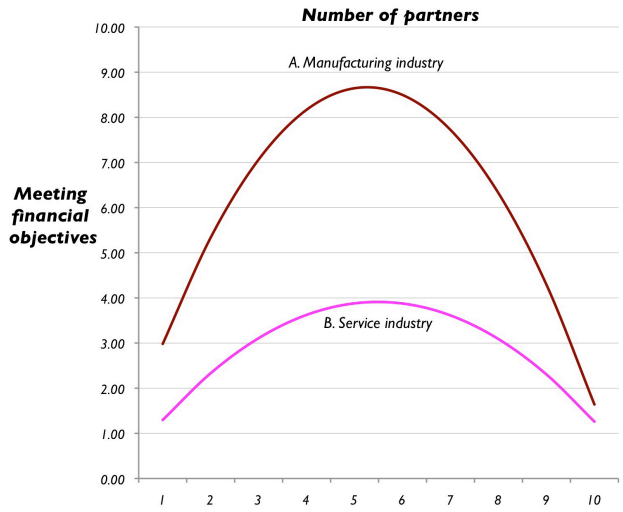


Figure D.7b: Differences of technical informality across industry



The number of partners has a significant curvilinear impact on meeting financial objectives in the manufacturing (Figure D.8, curve A) and in service industries (curve B).[5] Especially in manufacturing industry, cooperation between more than two companies is financially attractive. However, when more than 5 partners are involved in the co-innovation alliance, the risk of additional coordination costs or dilution of revenues is likely to surpass the additional value added.

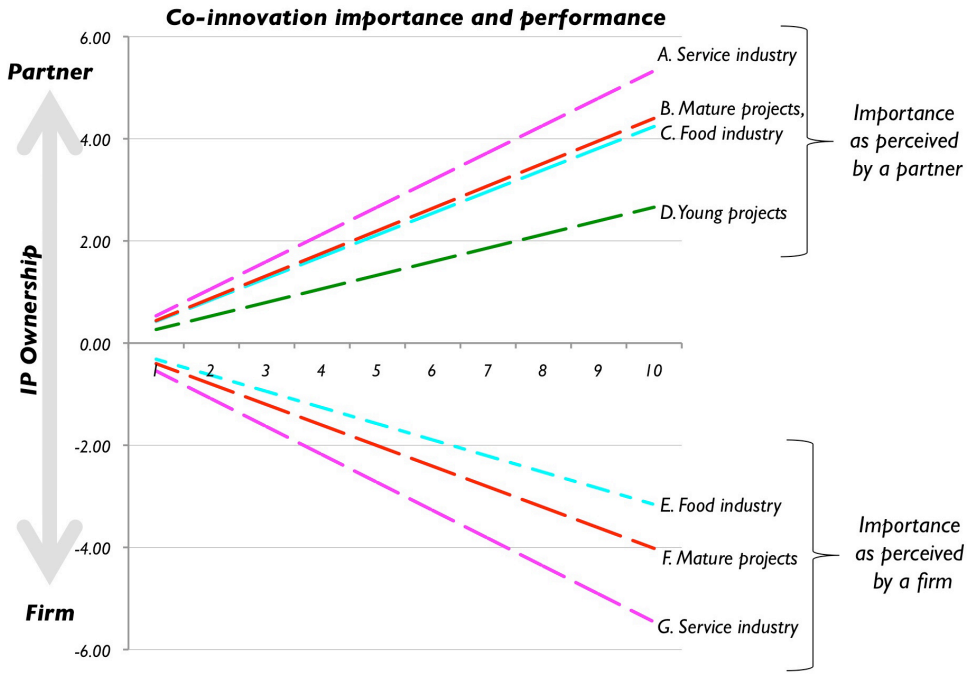
Figure D.8: Differences of the number of partners across industry



The importance of the co-innovation alliance, as perceived by a firm and its partner, affects IP ownership in different ways. When *partners* perceive the cooperation as important, partners tend to own a larger share of the jointly developed IP (Figure D.9, curves A, B C, D, and E), because the partners are more inclined to supply know how or resources. At the same time, if the focal *companies* perceive the cooperation as important, they tend to own a larger share of (curves E, F, G), because they may be less inclined to supply *their* resources or technology due to the fact that the firm has already done so. We observed these effects especially in service industries (curves A and G), and in mature projects (curves B and F).

[5] The results for meeting financial objectives in service industries should be interpreted with caution due to a limited number of observations per variable.

Figure D.9: Different effects of co-innovation importance



A firm's innovativeness, measured as percentage of research and development expense of the sales, has a positive impact on meeting financial objectives of the co-innovation alliance. Especially in the food industry innovative firms benefit financially (Figure D.10a, curve A), although small effects can also be observed in manufacturing industry (Figure D.10a, curve B). In the case of young co-innovation alliances, innovative companies tend to derive more financial benefit from the partnership (see FigureD.10b, curve A), although the benefit will shrink in more mature projects (Figure D.10b, curve B).

Figure D.10a: Differences of firm's Innovativeness across industry

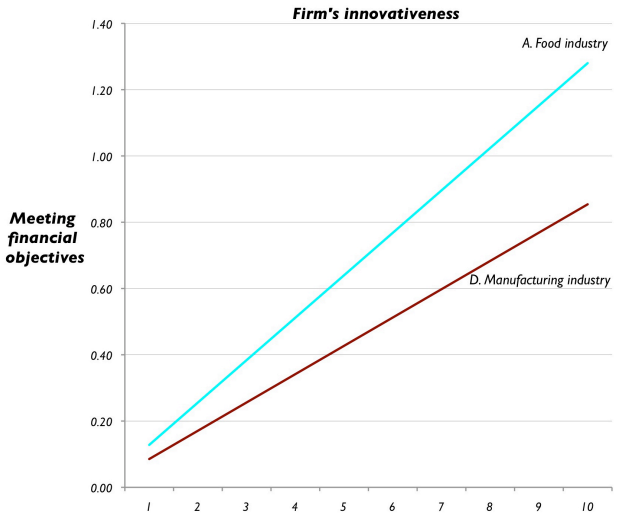
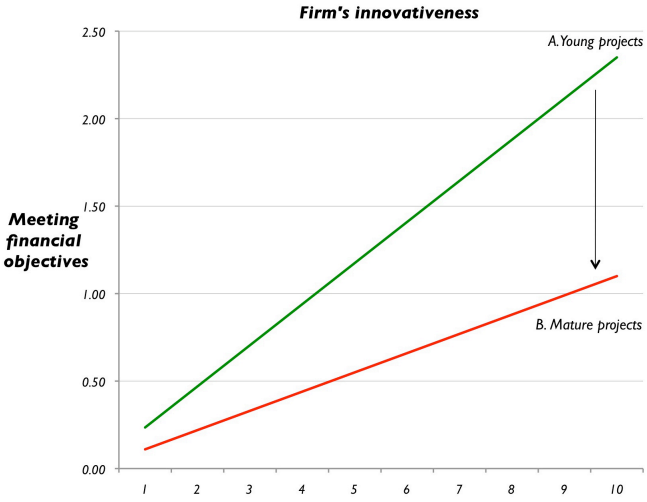


Figure D.10b: Differences of firm's innovativeness across project age



The ability of a firm and its partners to change its strategic priorities, referred to as *strategic stability*, positively affects meeting financial objectives in the manufacturing industry (Figure D.11a, curve A), where companies in the service industry that are able to adjust their activities in order to meet market needs, referred to as *operational flexibility*, tend to profit more from their co-innovation alliance although less prominently (curve B).

In mature projects, it is more important to adjust strategic priorities to changing market conditions than in young projects (see Figure D.11b, curves A and B).

Figure D.11a: Importance of stability and flexibility across industry

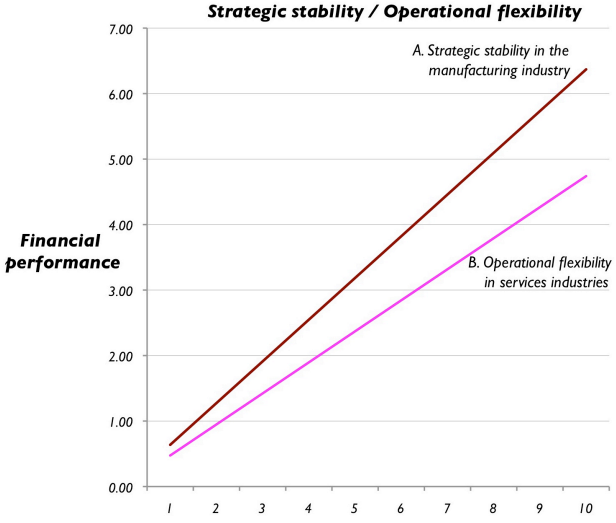
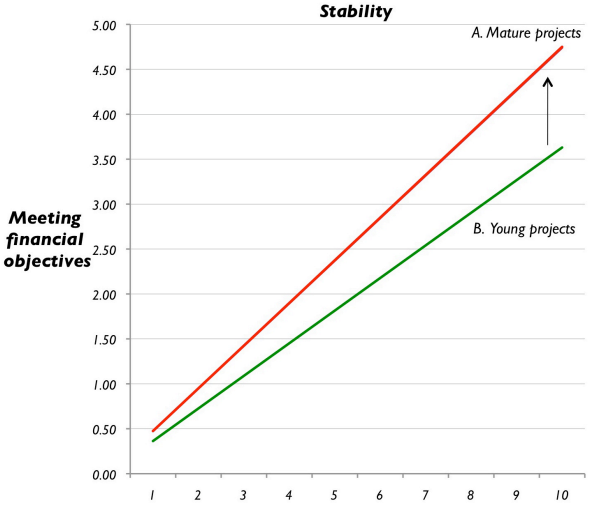


Figure D.11b: Differences of stability across project age

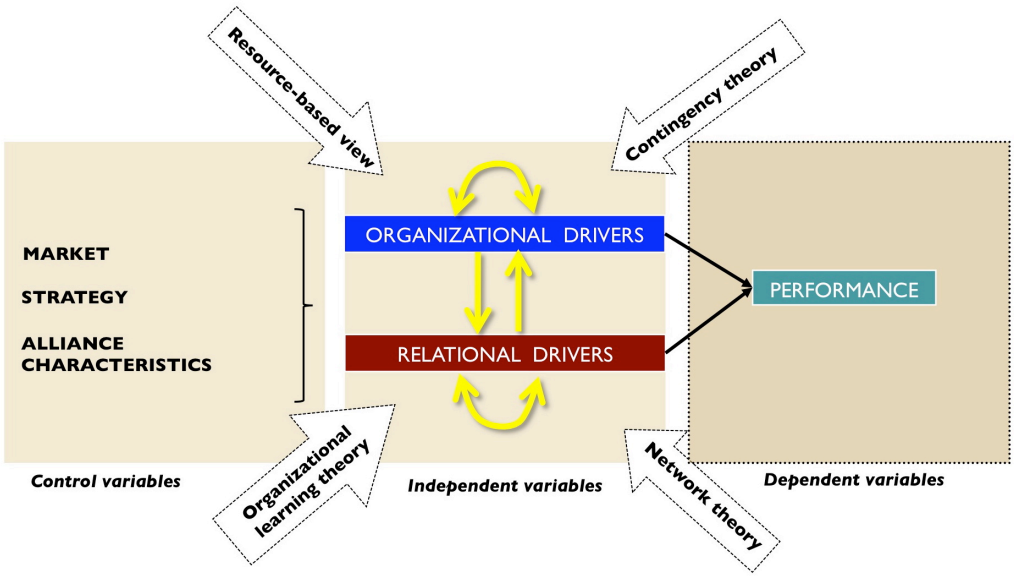


In conclusion: considering effects of industry and project duration is essential in the explanation and improvement of the performance of co-innovation alliances.

APPENDIX E: EFFECTS OF INTERACTION

In this appendix, we investigate some indirect effects in order (a) to explore new ground in search of new theory and (b) improve our management tool through data mining. We discuss some mediation and moderation effects between two independent variables in the COINN-model (see the yellow arrows in Figure E.1). [1]

Figure E.1: Interaction between the independent variables of the COINN model



An analysis of the effects of interaction is complicated due to the fact that many variables can potentially interact with one another. In various studies, the problem of cross-validating findings has been addressed (Parkhe, 1993b; Park and Ungson, 2001; Gilsing et al., 2007).

Depending on the values of a third variable - some effects of interaction might cause variation in the regressions between independent and dependent variables (Jaccard and Turrisi, 2003), known as moderation and mediation effects. Those effects differ from one another; in the case of *moderating* effects, a third variable influences the direction or strength of the relation between an independent and dependent variable, while in *mediating* effects, the relation between an independent and the dependent variable runs through a third vari-

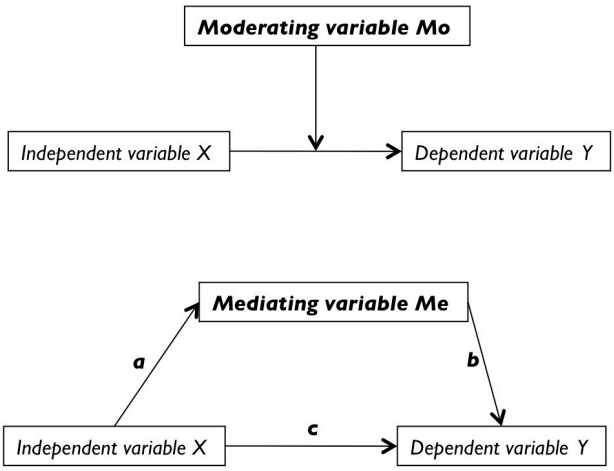
[1] We do not discuss other interaction effects, such as effects between more than two independent variables, or combinations of mediation and moderation (see e.g. Muller et al. 2005).

able (Baron and Kenny, 1986). In this case, a regression is compared with an indirect regression between the independent and the dependent variable. In Figure E.2, we explain the differences between moderation and mediation.

With *moderation*, the direction or strength of the relationship between independent variable **X** and dependent variable **Y** changes under the influence of moderating variable **Mo**. We measure moderation by adding interaction (product) terms to the regression models of Section 6.2. In order to deal with a minimum of observations per variable of at least five per independent variable, we simplified our models by removing non-significant variables from the analyses (Hair et al., 2010).

With *mediation*, the direct relation ***c*** is compared with the indirect effect of ***a*** and ***b***, assuming that ***a***, ***b***, and ***c*** are all significant. Mediation is known as *full* mediation if relation ***c*** is no longer significant, when ***a*** and ***b*** are removed from the analysis. In other cases, we speak of *partial* mediation. With mediation, a mediating variable ***Me*** influences the relation that an independent variable ***X*** has with a dependent variable ***Y***. In other words, ***X*** affects ***Y*** because ***X*** affects ***Me***, and ***Me***, in turn, affects ***Y*** (Peacher et al., 2007).

Figure E.2: Differences between moderation and mediation



We measured mediation by conducting Sobel-Goodman tests in STATA, which indicate whether an indirect (mediator) effect is significant (Baron and Kenny, 1986) and found significant effects of the organizational scales *firm's embeddedness, balanced competences, and coordination need*, as well as of the relationships scales *trust, technology transfer,* and *firm's management involvement* (see Table E.1).

Table E.1: Mediation effects

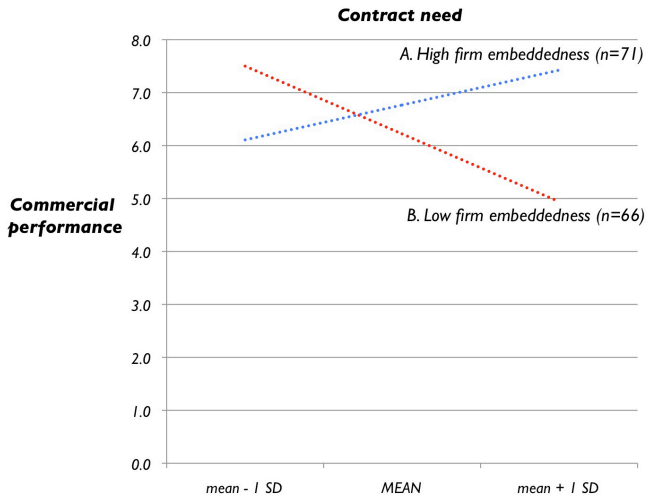
	Commercial performance	***Technological performance***	***Financial performance***
Contract need	NS	NS	NS
Firm's embeddedness	*Contract need°* *Balanced competences** *Firm's centrality** *Trust*** *Technology transfer**	*NS*	*Contract need°* *Balanced competences** *Coordination need°* *Trust** *Partner's management involvement°*
Firm's centrality	*NS*	*NS*	*NS*
Partner's embeddedness	*NS*	*NS*	*Trust°*
Balanced competences	*NS*	*Firm's embeddedness*** *Partner's competences*** *Trust*** *Technology transfer*** *Firm's management involvement** *Partner's management involvement**	*NS*
Coordination need	*Balanced competences°*	*NS*	*NS*
Trust	*NS*	*NS*	*Firm's management involvement°*
Culture fit	*NS*	*NS*	*NS*
Technology transfer	*Contract need°* *Trust** *Firm's management involvement°*	*Contract need°* *Firm's embeddedness** *Partner's embeddedness°* *Coordination need°* *Trust°*	*Contract need** *Firm's embeddedness*** *Partner's embeddedness** *Balanced competences*** *Coordination need** *Partner's competences* *Trust*** *Firm's management involvement** *Partner's management involvement°*
Firm's management involvement		*Technology transfer°* *Partner's management involvement** *Trust°*	
Partner's management involvement	*NS*	*NS*	*NS*
Technical informality	*NS*	*NS*	*NS*
Commercial informality	*NS*	*NS*	*NS*

*Notes * p<0.05, and ** p<0.01, NS: Sobel's test is non significant.*

In order to analyze the impact of the mediation effects, we divided our database at the median of the mediating variables and calculated the bivariate correlation coefficients between both the dependent and independent variables of the two samples separately and discuss some of the major changes in the coefficients.

In the regressions with *commercial* and *financial performance*, *firm's embeddedness* mediates various variables. Firms that have experience with many partnerships value detailed contracts positively in order to improve the relative position towards the partner as far IP, market rights and revenue is concerned[2] (see Figure E.3, curve A), whereas they value coordination positively as a means of achieving financial and strategic objectives[3] (Figure E.4, curve A). In contrast: firms without networking experience value contract details or coordination more negatively (Figures E.3 and E.4, curves B, respectively).

Figure E.3: Firm's embeddedness mediates contract need on commercial performance



In the regressions with technological performance, *balanced competences* influences various variables. The impact of a *firm's management involvement* on the extent to which complementary resources could be obtained depends on a situation of *balanced competences;* especially when the competences of the firm and its partner are not unique and easy to replace (*"low balanced competences"*). A *firm's management involvement* will have a positive impact on the accessibility of com-

[2] Referred to as *commercial performance*.
[3] Referred to as *financial performance*.

plementary resources[4] (Figure E.5, curve B).

Figure E.4: Firm's embeddedness mediates coordination need on financial performance

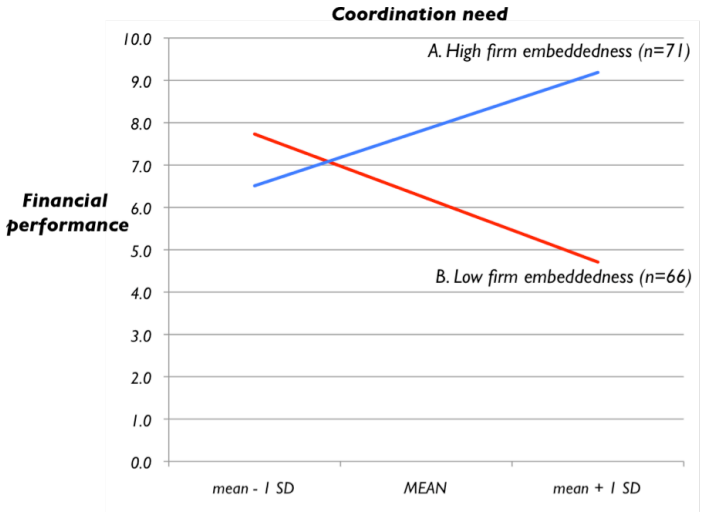
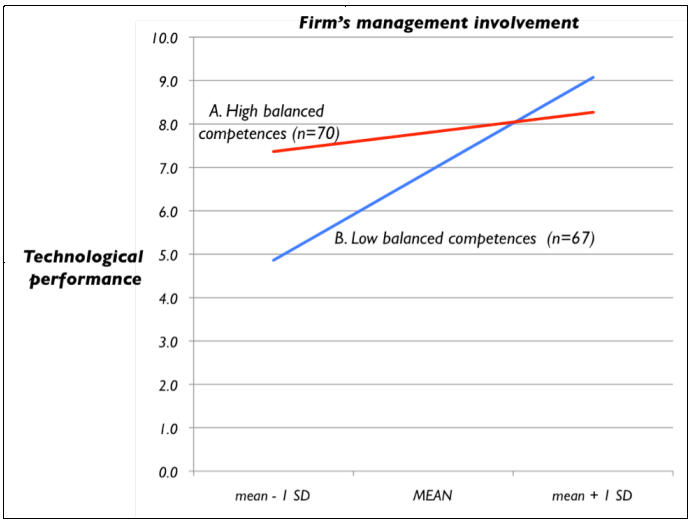


Figure E.5: Balanced competences mediate a firm's management involvement on technological performance



The ability to *transfer technology* serves as an important mediating variable as well. In the case of a high ability to *transfer technology*, a highly embedded firm

[4] Referred to as *technological performance*.

can achieve better financial results (Figure E.6, curve A), whereas if they lack the ability to transfer technology, highly embedded partners add to achieving beter financial results (Figure E.7, curve A).

Figure E.6: Technology transfer mediates firm's embeddedness on financial performance

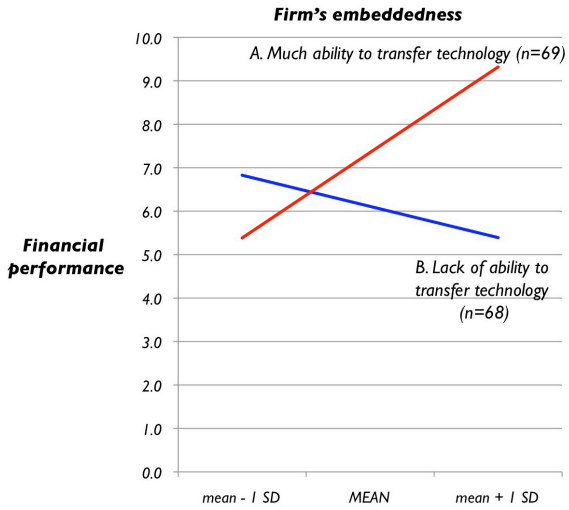
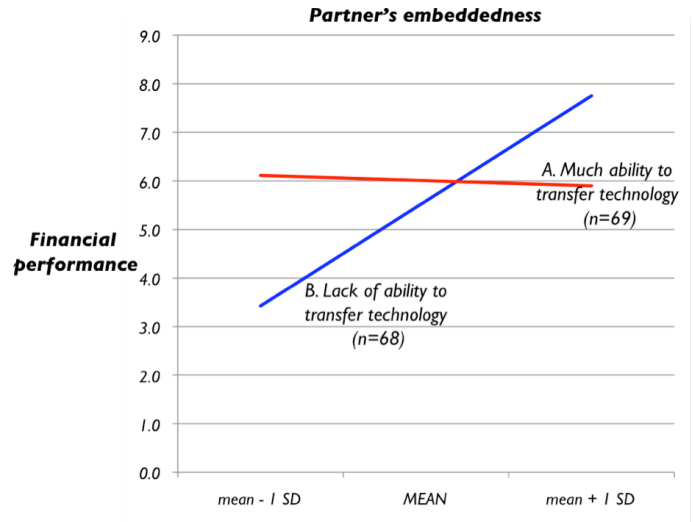


Figure E.7: Technology transfer mediates partner's embeddedness on financial performance



A better ability to *transfer technology* from and to others, involves on the one hand a higher learning efficiency and higher absorption capacity, while on the other hand entails more potential leakages of intellectual property. A co-innovation alliance can be considered as a "race to learn" (see Section 4.3.3). When highly embedded firms – with more network relationships and experience – have much ability to transfer technology, they can make effectively use of their own networks. In contrast, many network relationships of the partner are needed *only* in the case of a limited ability to transfer technology.

As far as the access to complementary resources is concerned, a *partner's embededdness* and a *firm's embeddedness* reinforce one another (positive moderation) while the ability to *transfer technology* in combination with *technological informality* interfere with one another (negative moderation) due to the risk of unnecessary disclosure of information.

We illustrate the complexity of improving performance of co-innovation alliances with the use of various moderation effects.

A combination of detailed contracts *("contract need")* and highly coordinated activities *("coordination need")* improves the relative position of a firm towards the partner as far IP, market rights and revenue is concerned (see Figure E.4).[5] However, *contract need* has a negative influence on financial performance (see Chapter 6). *Partner's embeddedness* moderates the negative effect positively (see Figure E.5): when the partner is highly embedded, detailed contracts with the partner are considered to be necessary in order to achieve financial and strategic objectives. A high degree of *partner embeddedness* improves the technological performance of a firm by improving opportunities to access complementary resources (curves AD and BD in Figure E.6). As discussed in Chapter 6, coordination of activities between the firm and its partners however, reduces the possibilities to access complementary resources due to the fact that flexibility is restricted (see the U-shaped curve in Figure 6.6 and the U-shaped curves AB and CD in Figure E.6). We observed a positive moderation between *coordination need* and *partner's embeddedness*.

[5] In the regressions with commercial performance including moderation variables, only the interaction term is significant.

Figure E.8: Coordination need and contract need moderate commercial performance

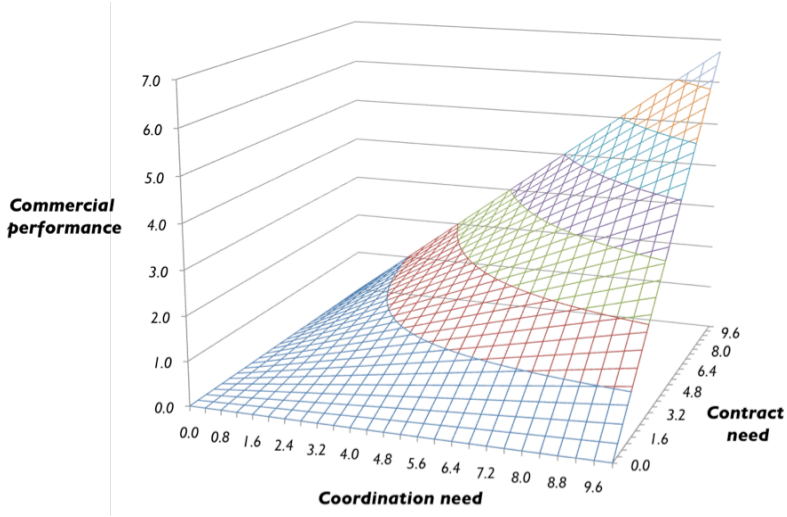


Figure E.9: Coordination need and partner's embeddedness moderate financial performance

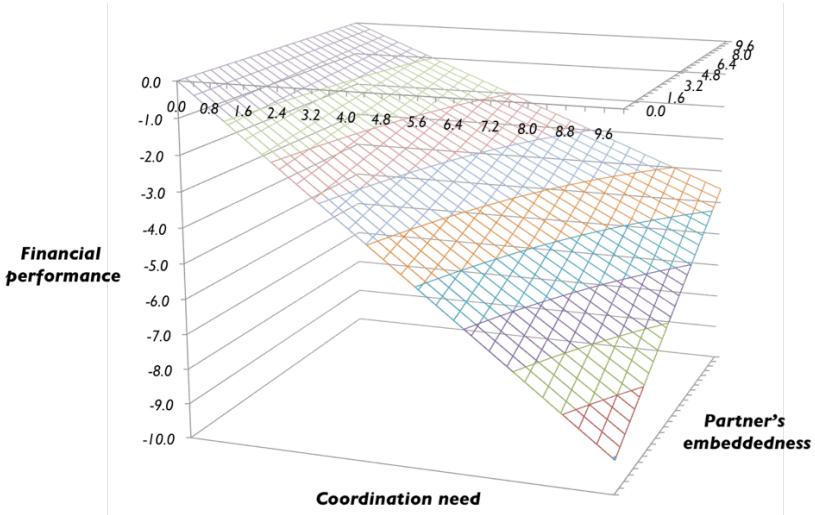
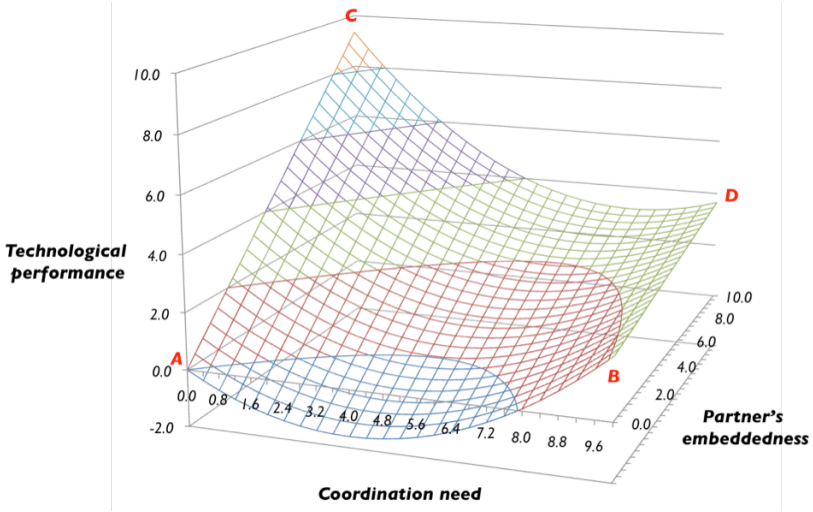


Figure E.10: Coordination need and partner's embeddedness moderate technological performance



Improving the performance of co-innovation alliances entails the ability to deal with the paradoxes between different aspects of performance. For example, on the one hand one should restrain the coordination of activities tightly in order not to limit the access to complementary resources (technological performance). On the other hand, coordination and contracts might be indispensable in order to obtain a fair share of commercial benefits or meet financial objectives.

The desired level of coordination is contingent upon a *firm's* and the *partner's embeddedness*, as well as its ability to *transfer technology*, and *balanced competences*.

In conclusion, the consideration of indirect effects is an essential element in the explanation and improvement of the performance of co-innovation alliances.

Table F.1: Factor analysis of the independent variables

INDEPENDENT VARIABLES	Rotated Component Matrix													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
4.2a Firm's role other partnerships	0.00	0.02	-0.03	0.07	-0.11	0.03	0.10	-0.07	0.17	0.01	**0.84**	0.01	0.04	-0.03
4.2b Partner's role other partnerships	-0.08	0.13	-0.02	-0.03	**0.79**	0.01	0.17	-0.11	0.08	-0.08	0.01	0.13	0.16	0.06
4.3a Firm's number of other partnerships	-0.06	-0.17	0.02	0.16	-0.06	0.04	-0.08	0.29	**0.70**	0.14	0.08	0.13	0.01	-0.04
4.3b Partner's number of other partnerships	0.05	-0.01	0.05	0.20	**0.80**	0.07	-0.04	-0.04	-0.04	0.08	-0.09	-0.06	-0.12	-0.19
4.4a Firm's coordination need	-0.08	-0.08	0.14	0.12	0.02	0.01	0.20	-0.04	-0.01	**0.82**	-0.05	-0.25	0.07	0.13
4.4b Partner's coordination need	0.11	0.14	0.05	0.03	-0.04	0.02	0.03	-0.07	0.12	**0.85**	0.15	0.17	-0.04	-0.02
4.5 Governance structure comparable	0.55	0.38	0.03	0.02	0.04	0.09	0.03	-0.07	0.01	-0.11	0.05	0.37	-0.23	0.22
4.6 Decision making control	0.10	-0.06	-0.07	-0.01	0.13	-0.03	0.34	0.12	0.14	0.22	0.44	0.14	-0.04	-0.09
4.7a Firm: contract details important	-0.04	0.02	**0.80**	-0.12	0.12	-0.07	-0.09	-0.08	-0.05	0.03	0.00	-0.18	0.19	0.20
4.7b Partner: contact details important	0.14	0.01	**0.78**	-0.03	0.06	-0.14	0.01	-0.25	-0.03	-0.03	0.05	0.03	0.07	0.07
4.8a Strategic issues informal	0.13	0.00	-0.04	-0.13	-0.07	0.02	-0.08	**0.86**	-0.02	-0.04	-0.03	0.02	-0.12	0.04
4.8b Marketing issues informal	0.07	-0.04	-0.04	0.00	-0.11	-0.10	0.11	**0.85**	0.07	-0.06	0.03	-0.04	0.06	-0.02
4.8c Financial issues informal	0.14	0.10	0.01	-0.07	-0.05	**0.72**	-0.17	0.00	0.14	0.15	0.14	0.25	0.03	0.24
4.8d R&D issues informal	0.04	0.11	-0.01	-0.02	-0.05	**0.72**	0.25	-0.11	-0.22	-0.09	-0.12	-0.06	-0.28	-0.06
4.8e Project management issues informal	-0.13	0.08	-0.20	-0.07	0.14	**0.75**	0.01	-0.01	-0.07	-0.02	-0.01	-0.08	0.13	-0.28
4.9a Firm: formal contract is important	-0.12	-0.14	**0.75**	0.15	-0.01	0.02	-0.05	0.20	0.20	0.14	-0.16	0.09	0.06	-0.02
4.9b Partner: formal contract is important	0.02	-0.02	**0.78**	0.19	-0.05	0.01	0.07	0.04	-0.06	0.06	0.00	0.14	-0.07	-0.17
4.10a Partner's competence are new	0.02	-0.17	-0.08	0.13	0.08	0.10	**0.74**	0.09	-0.34	0.14	0.08	-0.03	0.02	0.06
4.10b Firm's competence new	0.02	0.15	-0.08	-0.06	-0.06	-0.12	**0.59**	-0.11	0.27	0.30	0.16	0.13	0.11	0.07
4.11 Learning balance	0.10	-0.13	-0.08	0.28	0.30	-0.01	0.03	0.12	-0.25	-0.02	-0.15	-0.61	-0.24	0.07
4.12a Partner can replace	0.18	0.22	0.11	0.19	-0.15	0.01	**0.41**	-0.11	0.19	-0.16	-0.38	0.37	0.06	0.19
4.12b Firm can replace	0.10	-0.16	0.08	0.24	0.09	0.05	**0.45**	0.13	-0.22	-0.01	0.04	0.56	0.04	0.10
5.10a Firm's experience	0.03	-0.12	-0.02	0.19	0.07	-0.12	0.03	-0.12	**0.77**	0.02	0.12	-0.06	-0.05	0.00
5.10b Partner experience	0.14	0.30	0.08	-0.02	**0.73**	-0.03	-0.11	-0.11	-0.01	-0.02	0.07	-0.28	-0.04	0.08
5.11a Firm's management Involvement	0.13	0.07	0.03	0.09	-0.04	-0.08	0.07	0.03	-0.04	0.08	-0.10	0.03	0.10	0.84
5.11b Partner's management involvement	0.13	-0.08	0.08	0.07	-0.12	0.09	0.07	-0.06	-0.02	0.03	0.00	0.01	0.77	0.28
5.12a Tech transfer to extern	0.05	0.09	0.12	**0.68**	0.08	-0.04	0.26	-0.09	0.25	-0.05	0.04	-0.06	0.02	0.19
5.12b Tech transfer from extern	0.22	-0.02	-0.02	**0.81**	0.06	0.09	-0.01	-0.10	0.09	0.09	0.16	0.04	0.13	0.00
5.12c Retain relations	0.10	0.04	0.08	**0.85**	0.04	-0.16	-0.01	0.02	0.06	0.06	-0.09	-0.01	-0.05	-0.01
5.1a Firm's status	-0.03	0.13	0.26	0.01	0.20	-0.28	0.09	-0.02	-0.04	-0.03	-0.02	0.21	0.64	-0.32
5.1b Partner's status	0.04	0.01	0.12	0.36	0.40	-0.30	-0.02	0.08	-0.23	0.06	0.43	0.23	-0.15	-0.13
5.2 Communication style similar	0.12	**0.71**	-0.16	0.03	0.04	0.20	0.02	-0.04	0.08	0.02	-0.12	0.07	-0.12	-0.03
5.3 Decision style similar	0.11	**0.78**	-0.09	0.07	0.09	0.13	0.04	0.12	-0.10	0.08	0.28	-0.01	0.08	0.11
5.4 Leaderships style similar	0.11	**0.82**	0.08	0.04	0.07	0.05	-0.04	-0.02	-0.10	-0.11	0.02	0.03	0.12	0.03
5.5 Problem solving style similar	0.12	**0.75**	0.03	-0.04	0.15	-0.16	-0.01	-0.12	-0.14	0.13	-0.17	-0.05	-0.09	-0.03
5.6a Firm openness communication	**0.76**	0.18	0.08	-0.01	-0.02	0.05	0.05	-0.04	-0.02	-0.07	-0.19	0.20	0.12	0.09
5.6b Partner's openness communication	**0.85**	0.13	-0.01	-0.03	-0.04	0.05	-0.02	0.05	0.00	-0.10	0.02	0.01	-0.07	0.08
5.7 Partner meets obligation	**0.71**	0.06	0.16	0.18	-0.07	-0.11	0.06	-0.08	-0.10	0.01	0.07	-0.11	0.08	-0.06
5.8a We give responsibility	0.42	0.24	0.27	0.21	-0.03	0.15	0.37	0.00	0.16	-0.26	0.21	-0.13	0.11	-0.04
5.8b Partner gives responsibility	0.43	0.27	0.20	-0.01	-0.01	0.20	0.42	0.04	0.33	-0.07	0.16	0.00	0.05	-0.18
5.9a Partner shares expertise	**0.79**	0.06	-0.12	0.14	0.16	0.06	-0.05	0.14	0.02	0.16	0.06	-0.04	0.06	0.04
5.9b Firm shares expertise	**0.74**	-0.05	-0.17	0.17	0.09	-0.12	0.09	0.24	0.05	0.18	0.02	-0.06	-0.02	0.02
5.10a Firm's experience	0.03	-0.12	-0.02	0.19	0.07	-0.12	0.03	-0.12	0.77	0.02	0.12	-0.06	-0.05	0.00
5.10b Partner experience	0.14	0.30	0.08	-0.02	0.73	-0.03	-0.11	-0.11	-0.01	-0.02	0.07	-0.28	-0.04	0.08
5.11a Firm's management Involvement	0.13	0.07	0.03	0.09	-0.04	-0.08	0.07	0.03	-0.04	0.08	-0.10	0.03	0.10	**0.84**
5.11b Partner's management involvement	0.13	-0.08	0.08	0.07	-0.12	0.09	0.07	-0.06	-0.02	0.03	0.00	0.01	**0.77**	0.28
5.12a Tech transfer to extern	0.05	0.09	0.12	0.68	0.08	-0.04	0.26	-0.09	0.25	-0.05	0.04	-0.06	0.02	0.19
5.12b Tech transfer from extern	0.22	-0.02	-0.02	0.81	0.06	0.09	-0.01	-0.10	0.09	0.09	0.16	0.04	0.13	0.00
5.12c Retain relations	0.10	0.04	0.08	0.85	0.04	-0.16	-0.01	0.02	0.06	0.06	-0.09	-0.01	-0.05	-0.01

Principal Component Analysis, Varimax rotation with Kaiser Normalization converged in 32 iterations.

Table F.2: Factor analysis of the dependent variables

DEPENDENT VARIABLES	Rotated Component Matrix			
	1	2	3	4
6.1 Contribute to competitive position	-0.19	0.62	0.23	0.37
6.2 Possibility to integrate	-0.04	0.45	0.55	0.06
6.3 Less risk/uncertainty	-0.18	0.59	0.07	0.11
6.4 Better innovative position	0.09	0.41	-0.02	0.64
6.5 Extra complementary resources	-0.03	0.13	-0.01	**0.74**
6.6 Research synergies	-0.11	0.07	0.14	0.60
6.7 Marketing benefits	**0.83**	-0.09	0.02	-0.13
6.8 Sharing risk/revenue	**0.88**	-0.04	-0.03	-0.06
6.9 IP Ownership	**0.84**	0.06	-0.01	0.06
6.10 Cash spending	0.65	-0.21	0.07	0.06
6.13 Break even	0.11	0.64	0.04	-0.05
6.15 Revenue growth	-0.15	0.67	0.10	0.21
6.16a Meeting financial goals	0.08	0.16	**0.87**	-0.06
6.16b meeting strategic goals	-0.05	0.06	**0.81**	0.24
6.16c meeting learning goals	0.14	-0.09	0.49	0.57

Note: Principal Component Analysis, Varimax rotation with Kaiser Normalization, converged in 5 iterations.

Table F.3: Factor analysis of the market control variables

Market control variables	Rotated Component Matrix		
	1	2	3
2.1 Ambiguity	0.38	-0.39	0.44
2.2 Complexity	0.64	-0.11	0.33
2.3 Risk	**0.85**	0.09	0.01
2.4 Uncertainty	**0.86**	0.02	-0.11
2.5 Technological intensity	0.15	**0.80**	-0.04
2.6 Life cycle market	0.07	-0.06	0.64
2.7 External turbulence	-0.06	0.08	0.81
2.8 Knowledge concentration	-0.10	**0.81**	0.02

Note: Principal Component Analysis, Varimax Rotation with Kaiser Normalization converged in 5 iterations.

Table F.4: Factor analysis of the strategic control variables

Strategy control variables	Rotated Component Matrix				
	1	2	3	4	5
3.1a Strategic motives firm	0.13	0.20	0.58	-0.31	-0.10
3.1b Strategic motives partner	0.43	-0.16	-0.06	-0.04	0.49
3.2a Technological motives firm	-0.15	0.40	0.18	0.05	**0.70**
3.2b Technological motives partner	0.22	-0.02	0.06	-0.20	**0.73**
3.3a Financial motives firm	-0.06	0.06	**0.85**	-0.15	0.03
3.3b Financial motives partner	-0.09	-0.09	**0.62**	0.18	0.34
3.4 Strategic match	0.63	0.24	-0.22	-0.21	-0.07
3.5a Organizational flexibility firm	-0.08	**0.83**	0.09	-0.06	-0.04
3.5b Organizational flexibility partner	**0.81**	-0.01	-0.04	0.24	0.16
3.6a Managerial flexibility firm	0.14	**0.78**	-0.01	-0.04	0.11
3.6b Managerial flexibility partner	**0.87**	-0.03	0.11	0.09	0.10
3.7a Change strategic priorities firm	0.06	-0.17	-0.14	**0.78**	-0.03
3.7b Change strategic priorities partner	0.10	0.08	-0.02	**0.81**	-0.14
4.1 Initial conditions	0.25	0.28	-0.35	-0.30	-0.02

Notes: Principal Component Analysis, Varimax Rotation with Kaiser Normalization converged in 9 iterations.

Table F.5: Regressions with commercial performance

		COMMERCIAL PERFORMANCE				
		MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
Control variables	NR.OF PARTNERS	1.71*	1.33*	1.32°	1.35°	1.31
		(2.61)	(2.03)	(1.98)	(1.93)	(1.63)
	NR.OF PARTNERS (Quadratic)	-0.20**	-0.16*	-0.15*	-0.16*	-0.15
		(-3.28)	(-2.48)	(-2.29)	(-2.22)	(-1.91)
		-0.24**	-0.22*	-0.22*	-0.20°	-0.22°
		(-2.80)	(-2.55)	(-2.61)	(-1.86)	(-1.67)
	PARTNER'S STRATEGIC MOTIVES	-0.19*	-0.21*	-0.19*	-0.20°	-0.19
		(-2.29)	(-2.19)	(-2.23)	(-1.89)	(-1.26)
	FIRM'S FLEXIBILITY	-0.38***	-0.31***	-0.30***	-0.30**	-0.32**
		(-4.29)	(-4.45)	(-3.88)	(-3.20)	(-2.95)
Organizational variables	CONTRACT NEED		0.10	0.40	0.29	0.28
			(1.15)	(0.74)	(0.46)	(0.45)
	CONTRACT NEED (Quadratic)			-0.03	-0.01	-0.02
				(-0.56)	(-0.27)	(-0.29)
	FIRM'S EMBEDDEDNESS		-0.24°	-0.08	-0.05	0.01
			(-1.76)	(-0.11)	(-0.06)	(0.01)
	FIRM'S EMBEDDEDNESS (Quadratic)			-0.01	-0.01	-0.02
				(-0.18)	(-0.19)	(-0.22)
	FIRM'S CENTRALITY		-0.05	-0.05	-0.09	-0.03
			(-0.40)	(-0.12)	(-0.19)	(-0.05)
	FIRM'S CENTRALITY (Quadratic)			0.00	0.00	0.00
				(-0.01)	(0.09)	(-0.05)
	PARTNER'S EMBEDDEDNESS		-0.06	0.06	0.11	0.09
			(-0.60)	(0.11)	(0.21)	(0.18)
	PARTNER'S EMBEDDEDNESS (Quadratic)			-0.01	-0.01	-0.01
				(-0.16)	(-0.27)	(-0.19)
	PARTNER'S COMPETENCES		0.05	-0.67°	-0.63	-0.65
			(0.75)	(-1.86)	(-1.60)	(-1.46)
	PARTNER'S COMPETENCES (Quadratic)			0.061*	0.06	0.06
				(2.05)	(1.88)	(1.68)
	COORDINATION NEED		-0.10	0.03	0.03	0.05
			(-1.11)	(0.07)	(0.08)	(0.12)
	COORDINATION NEED (Quadratic)			-0.01	-0.01	-0.01
				(-0.29)	(-0.29)	(-0.21)
Relationational variables	TRUST				0.01	0.12
					(0.04)	(0.09)
	TRUST (Quadratic)					-0.01
						(-0.09)
	CULTURAL FIT				0.05	-0.21
					(0.47)	(-0.47)
	CULTURAL FIT (Quadratic)					0.03
						(0.62)
	TECHNOLOGY TRANSFER				-0.06	0.05
					(-0.46)	(0.09)
	TECHNOLOGY TRANSFER (Quadratic)					-0.01
						(-0.21)
	FIRM'S MANAGEMENT INVOLVEMEMENT				0.00	-0.04
					(0.01)	(-0.06)
	FIRM'S MANAGEMENT INVOLVEMEMENT (Quadratic)					0.00
						(0.08)
	PARTNER'S MANAGEMENT INVOLVEMENT				-0.03	-0.40
					(-0.33)	(-0.90)
	PARTNER'S MANAGEMENT INVOLVEMENT (Quadratic)					0.03
						(0.88)
	TECHNICAL INFORMALITY				-0.03	-0.26
					(-0.24)	(-0.48)
	TECHNICAL INFORMALITY (Quadratic)				0.04	0.23
					(0.38)	(0.51)
	COMMERCIAL INFORMALITY					0.02
						(0.46)
	COMMERCIAL INFORMALITY (Quadratic)					-0.02
						(-0.43)
	_cons	9.153***	11.32***	10.73**	10.80**	11.36*
		(7.08)	(6.18)	(3.06)	(2.74)	(2.14)
	N	134	132	132	132	132
	R-sq	29.0%	36.2%	39.7%	40.3%	41.5%
	adj. R-sq	25.1%	29.1%	29.5%	25.6%	21.7%
	F	15.02	1.63	1.00	0.30	0.39
	P > F	0%	16%	44%	95%	34%

*Notes: t statistics in parentheses, ° p< 0.1, * p<0.05, ** p<0.01, *** p<0.001, F-test: significance compared with the previous model*

Table F.6: Regressions with technological performance

TECHNOLOGICAL PERFORMANCE					
	MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**	**MODEL 5**
FIRM'S MULTI INPUT	1.15***	1.00**	1.13**	1.12**	0.85
	(3.59)	(2.74)	(2.72)	(2.71)	(1.89)
FIRM'S INNOVATIVENESS	-0.01	-0.02	-0.04	-0.07	-0.09°
	(-0.21)	(-0.49)	(-0.90)	(-1.59)	(-1.83)
PARTNER'S IMPORTANCE	0.25*	0.26*	0.29*	0.34**	0.25
	(2.33)	(2.47)	(2.67)	(3.04)	(2.00)
TECHNOLOGICAL MOTIVES	0.42***	0.36**	0.337*	0.25°	0.27°
	(3.53)	(2.78)	(2.45)	(1.80)	(1.70)
CONTRACT NEED		-0.29*	0.24	0.26	0.29
		(-2.31)	(0.44)	(0.45)	(0.51)
CONTRACT NEED			-0.05	-0.05	-0.05
(Quadratic)			(-0.99)	(-1.04)	(-1.06)
FIRM'S EMBEDDEDNESS		0.04	0.02	-0.27	-0.69
		(0.30)	(0.03)	(-0.40)	(-1.00)
FIRM'S EMBEDDEDNESS			0.00	0.02	0.05
(Quadratic)			(-0.03)	(0.32)	(0.85)
FIRM'S CENTRALITY		-0.02	0.16	0.22	0.51
		(-0.21)	(0.42)	(0.49)	(1.01)
FIRM'S CENTRALITY			-0.02	-0.02	-0.04
(Quadratic)			(-0.62)	(-0.48)	(-0.92)
PARTNER'S EMBEDDEDNESS		0.04	0.34	0.47	0.47
		(0.32)	(0.91)	(1.17)	(1.33)
PARTNER'S EMBEDDEDNESS			-0.02	-0.04	-0.04
(Quadratic)			(-0.72)	(-0.93)	(-0.99)
PARTNER'S COMPETENCES		0.11	0.19	0.08	-0.05
		(0.92)	(0.36)	(0.19)	(-0.13)
PARTNER'S COMPETENCES			-0.01	0.00	0.00
(Quadratic)			(-0.15)	(0.01)	(0.12)
COORDINATION NEED		-0.03	-1.29*	-1.32*	-1.61**
		(-0.28)	(-2.59)	(-2.66)	(-2.94)
COORDINATION NEED			0.11*	0.11*	0.14**
(Quadratic)			(2.42)	(2.55)	(2.91)
TRUST				-0.05	-2.49°
				(-0.28)	(-1.72)
TRUST					0.19°
(Quadratic)					(1.72)
CULTURAL FIT				-0.07	0.33
				(-0.55)	(0.58)
CULTURAL FIT					-0.04
(Quadratic)					(-0.75)
TECHNOLOGY TRANSFER				0.25	1.59°
				(1.50)	(1.69)
TECHNOLOGY TRANSFER					-0.11
(Quadratic)					(-1.38)
FIRM'S MANAGEMENT INVOLVEMEMENT				0.25°	0.49
				(1.78)	(0.91)
FIRM'S MANAGEMENT INVOLVEMEMENT					-0.02
(Quadratic)					(-0.43)
PARTNER'S MANAGEMENT INVOLVEMENT				-0.22°	-0.57
				(-1.87)	(-1.19)
PARTNER'S MANAGEMENT INVOLVEMENT					0.03
(Quadratic)					(0.67)
TECHNICAL INFORMALITY				0.06	-0.09
				(0.47)	(-0.19)
TECHNICAL INFORMALITY					0.02
(Quadratic)					(0.34)
COMMERCIAL INFORMALITY				0.03	0.42
				(0.41)	(1.02)
COMMERCIAL INFORMALITY					-0.04
(Quadratic)					(-0.97)
_cons	0.03	1.85	2.65	1.80	7.31
	(0.02)	(1.17)	(1.04)	(0.53)	(1.42)
N	134	132	132	132	132
R-sq	21.0%	25.7%	30.2%	37.6%	42.2%
adj. R-sq	18.6%	19.5%	20.4%	24.3%	25.0%
F	9.49	1.14	1.14	1.31	1.11
P > F	0%	36%	35%	27%	37%

*Notes: t statistics in parentheses, ° p< 0.1, * p<0.05, ** p<0.01, *** p<0.001, F-test: significance compared with the previous model.*

Table F.7: Regressions with financial performance

		FINANCIAL PERFORMANCE				
		MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
Control variables	PROJECT DURATION	0.25°	0.36*	0.30*	0.20	0.22
		(1.94)	(2.44)	(2.07)	(1.10)	(1.17)
	PROJECT DURATION (Quadratic)	-0.01*	-0.02**	-0.01*	-0.01	-0.01
		(-2.60)	(-3.16)	(-2.53)	(-1.26)	(-1.36)
	LIFE CYCLE PHASE	0.79*	0.86**	0.94**	0.61°	0.67°
		(2.69)	(2.88)	(3.11)	(1.83)	(1.80)
	LIFE CYCLE PHASE (Quadratic)	-0.07*	-0.08**	-0.09**	-0.05°	-0.06°
		(-2.68)	(-2.90)	(-3.17)	(-1.68)	(-1.75)
	PARTNER'S NATIONALITY	0.98°	0.82°	1.03*	1.04°	1.08°
		(1.83)	(1.67)	(2.27)	(1.89)	(1.93)
	FIRM'S SALES P. EMPLOYEE	0.72***	0.66***	0.71**	0.59**	0.68**
		(3.87)	(3.91)	(3.32)	(2.92)	(3.23)
	FIRM'S INNOVATIVENESS	0.11***	0.11**	0.11**	0.11***	0.11***
		(4.01)	(3.46)	(3.46)	(3.82)	(3.57)
	KNOWLEDGE CONCENTRATION	0.17°	0.12	0.15°	0.19*	0.18°
		(1.77)	(1.34)	(1.73)	(2.37)	(1.99)
Organizational variables	CONTRACT NEED		-0.11	-1.29***	-1.51***	-1.39***
			(-1.20)	(-3.53)	(-4.72)	(-3.90)
	CONTRACT NEED (Quadratic)			0.096**	0.12***	0.11**
				(2.86)	(3.93)	(3.27)
	FIRM'S EMBEDDEDNESS		0.07	-0.84	-0.69	-0.69
			(0.65)	(-1.46)	(-1.57)	(-1.44)
	FIRM'S EMBEDDEDNESS (Quadratic)			0.07	0.05	0.05
				(1.39)	(1.24)	(1.10)
	FIRM'S CENTRALITY		0.13	1.11***	1.30***	1.22***
			(1.07)	(3.71)	(4.75)	(4.29)
	FIRM'S CENTRALITY (Quadratic)			-0.08**	-0.10***	-0.10***
				(-3.16)	(-4.06)	(-3.83)
	PARTNER'S EMBEDDEDNESS		0.20°	-0.13	-0.30	-0.23
			(1.78)	(-0.32)	(-0.93)	(-0.71)
	PARTNER'S EMBEDDEDNESS (Quadratic)			0.02	0.03	0.03
				(0.62)	(1.04)	(0.91)
	PARTNER'S COMPETENCES		0.07	-0.10	-0.09	-0.07
			(0.87)	(-0.18)	(-0.17)	(-0.14)
	PARTNER'S COMPETENCES (Quadratic)			0.01	0.01	0.01
				(0.32)	(0.27)	(0.28)
	COORDINATION NEED		-0.10	0.00	-0.18	-0.14
			(-1.47)	(-0.00)	(-0.50)	(-0.39)
	COORDINATION NEED (Quadratic)			0.00	0.01	0.00
				(-0.09)	(0.31)	(0.09)
Relationational variables	TRUST				0.01	0.12
					(0.09)	(0.11)
	TRUST (Quadratic)					0.00
						(-0.06)
	CULTURAL FIT				0.18°	0.28
					(1.72)	(0.80)
	CULTURAL FIT (Quadratic)					-0.01
						(-0.36)
	TECHNOLOGY TRANSFER				0.34*	0.17
					(2.30)	(0.41)
	TECHNOLOGY TRANSFER (Quadratic)					0.01
						(0.25)
	FIRM'S MANAGEMENT INVOLVEMEMENT				-0.03	0.30
					(-0.48)	(0.78)
	FIRM'S MANAGEMENT INVOLVEMEMENT (Quadratic)					-0.03
						(-0.79)
	PARTNER'S MANAGEMENT INVOLVEMENT				0.10	0.17
					(1.11)	(0.52)
	PARTNER'S MANAGEMENT INVOLVEMENT (Quadratic)					-0.01
						(-0.20)
	TECHNICAL INFORMALITY				0.03	-0.12
					(0.43)	(-0.32)
	TECHNICAL INFORMALITY (Quadratic)					0.02
						(0.43)
	COMMERCIAL INFORMALITY				0.15*	-0.15
					(2.16)	(-0.46)
	COMMERCIAL INFORMALITY (Quadratic)					0.03
						(0.97)
	_cons	-0.19	-1.86	2.40	-0.55	-1.05
		(-0.15)	(-1.07)	(0.88)	(-0.21)	(-0.27)
	N	132	130	130	130	130
	R-sq	35.1%	41.3%	49.5%	58.1%	59.5%
	adj. R-sq	29.1%	32.4%	38.6%	45.4%	43.2%
	F	7.5	2.17	2.87	2.18	0.52
	P > F	0%	6%	2%	5%	81%

*Notes: t statistics in parentheses, ° p< 0.1, * p<0.05, ** p<0.01, *** p<0.001, F-test: significance compared with the previous model*

APPENDIX G: CURRICULUM VITAE

Frans Stel is a senior consultant, manager and academic professional with a broad experience over two decades. His expertise is in business development, innovation consultancy and project management, e.g. managing international joint ventures, partner selection and evaluation, product and technology development, market and feasibility studies.

Frans obtained a Bachelors degree in Economics (1980) and Masters degree in Business and management at the University of Groningen (1985). He wrote his MSc-thesis on market entry strategies regarding Southeast Asian markets and intercultural management. At the Euro Asia Center of INSEAD, he attended senior management courses on strategies for Pacific Asia, management skills and business opportunities. He is trained in industrial chemistry and technology, consulting skills and open innovation.

After graduation, Frans became researcher at the University of Groningen (1985-97). He worked on a PhD-thesis on Headquarter – subsidiary relations of multinational companies (unfinished) and tought international marketing. He became consultant and area sales manager at DSM Chemicals (1988-93). In this period, he directed business development projects employing agents in Norway, Denmark, Finland, Portugal, Switzerland, and Italy. He conducted consultancy projects on reorganization of departments and customer focus. As next step, he was appointed director of the Europrint Group Veendam (1993-1996), a specialized security printer in a period of transition from a family oriented business towards a modern industry. By means of streamlining the production and sales, reorganization and investments, Frans prepared the sale of the company to new shareholders. As a freelancer, he conducted market research, business development projects, and feasibility studies (1996-1999) concerning the distribution and local production of Dutch machinery and materials in Canada. He started a joint venture with a Canadian partner. As project manager investment promotion at NV NOM (1999 – 2005), he assisted entrepreneurs and directors at the implementation of their investments, e.g. by preparing venture capital requests, forming international consortia, reviewing business plans, or resolving bottlenecks. Since 2006, Frans is co-owner and managing consultant at CreateNewBusiness BV, which is a consultancy, project management, training and coaching company.

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[BACK COVER]

Frans Stel

Improving the performance of co-innovation alliances

Cooperating effectively with new business partners

There is little doubt that open Innovation can boost the performance of new business development, where it enables higher R & D output and faster market introduction at lower costs. It is considered to have become the dominant innovation model and therefore a necessity in the competitive world of modern business practice. Unfortunately, open innovation is difficult to implement due to increased complexities. The main objective of this study is to develop and test a theoretical and evidence-based framework in order to improve the performance of co-innovation alliances. The research questions are (*1) Which factors and processes are known to diagnose and manage co-innovation alliances? (2) How do they differ in the case of different objectives? (3) Which changes result in higher performance? and (4) How do the factors and processes relate to one another?* In this study, facilitating and blocking factors and processes are transferred into performance indicating scales. We base our scales on contributions of contingency, network, organizational learning, and resource-based theory as well as research on joint ventures, strategic alliances and inter-firm cooperation. A framework is developed consisting of dependent variables (commercial, technological and financial performance), independent variables (organizational and relationship drivers) and control variables (characteristics regarding the alliance, market and strategy). Following principal component analysis, scales are constructed which show the relationship to performance of various drivers: *contract, coordination, competences, embeddedness, governance structure, trust, culture, technology transfer, management involvement and personal relations*. Based on data from questionnaire guided interviews involving 137 co-innovation partnerships in 51 companies, and using multivariate regressions analysis, hypotheses are tested and interaction effects are explored. The study reveals evidence that various organizational and relational drivers are linearly or curvilinearly (U-shaped or hill-shaped) related to performance and differ according to the type of performance, industry and project maturity. Furthermore, optimal levels of the drivers are indicated. Improving the performance of co-innovation is considered to be a multi-level challenge, in which the individual, team, organizational and inter-organizational level interact with one another. By optimizing the relevant drivers at the appropriate time, the performance of co-innovation alliances can be improved. The framework serves as a benchmark tool for co-innovation alliances.