Capturing value from external NPD collaboration — the significant role of market information processing

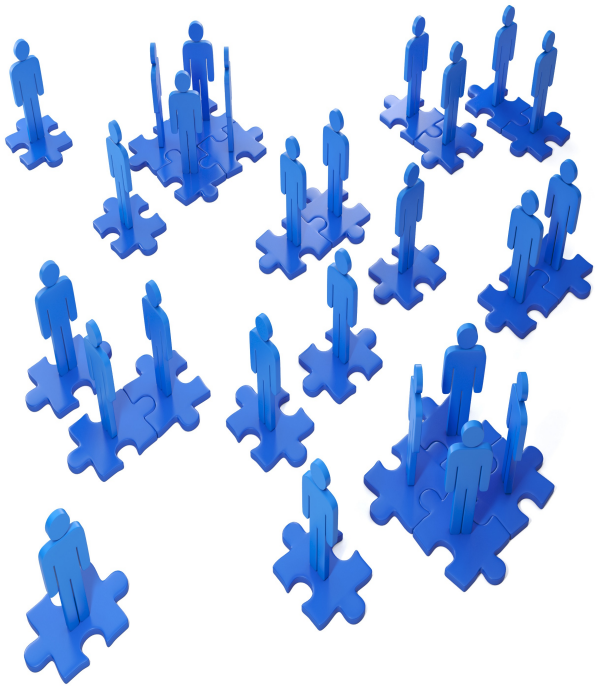
Tandrup, Thomas

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

Capturing value from external NPD collaboration

— the significant role of market information processing



Ph.D. Thesis
Thomas Tandrup
July 2015

DTU Management Engineering
Department of Management Engineering

Summary

Collaborating with external sources is becoming an integral part of the way many firms conduct innovation and develop new products. By turning to different parts of the value chain, firms can collect information pertinent to product development from a wide range of industry and market actors. By including customers, suppliers, competitors, universities, and other external experts in the development process, firms gain access to information, knowledge, and ideas that otherwise would have been out of reach.

Extensive previous research has documented the beneficial effects of collaborating with many different external sources, from customers to competitors. However, there are several gaps in the literature regarding the dynamics of integrating external sources into the process of developing new products. The current literature focuses primarily on testing how collaborating with one specific external source, such as customers, contributes to the NPD process. Moreover, the majority of these studies focus on the dynamics of collaboration within a single industry. Thus, the current literature fails to grasp what happens when multiple external sources are brought into the same NPD project. Furthermore, the focus on specific industries and types of collaborators has created uncertainty as to the effectiveness of external sources in NPD. This uncertainty is has been caused partially by the fact that there is very little research on the firm-level capabilities needed to successfully engage with external sources.

This study contributes to the existing knowledge of firms' use of external sources in new product development. A model is presented that tests the effectiveness of external collaboration when multiple external sources have to be managed simultaneously. Also, firms' ability to process information is included, as a central capability that allows them to identify the right collaborators for NPD projects, collect information from them, and disseminate that information throughout their organization. Finally, in the model, the level of novelty involved in new product development is included as a way of determining whether it is any more difficult to collaborate with external sources and process information about products that are completely new to the market.

This thesis presents a model that points out how difficult it is to collaborate with many external sources unless the firm has the right formal and informal capabilities in place for finding the right partners and extracting information from them for use in the NPD process. Moreover, the model highlights the difficulties of collaborating with external sources when the project is so new that it is outside external collaborators' frame of reference.

Dansk resumé

Det er blevet en integreret del af den måde mange virksomheder arbejder med innovation og produktudvikling på, at benytte sig af eksterne samarbejdspartnere. Ved at inkludere kunder, leverandører, konkurrenter, universiteter og andre eksterne eksperter i udviklingsprocessen, får virksomheder adgang til information, viden og ideer, der ellers ville have været uden for rækkevidde.

Omfattende forskning har tidligere dokumenteret de gavnlige virkninger i at samarbejde med eksterne kilder, uanset om det er kunder eller konkurrenter. Der er imidlertid flere huller i litteraturen i forhold til selve integrationen af eksterne kilder. Den nuværende litteratur fokuserer primært på at teste, hvordan et samarbejde med én bestemt ekstern kilde, f.eks. kunder, påvirker produktudvikling og kan således ikke redegøre for, hvad der sker, når flere eksterne kilder bringes ind i samme projekt. Desuden har tidligere studier primært beskæftiget sig med brugen af eksterne kilder i produktudvikling indenfor en specifik branche. Dette har skabt usikkerhed om den påviste effekt kan generaliseres til alle brancher. Forskningen indenfor dette felt har således vist sig mangelfuld og understreger behovet for en øget viden om hvilke kompetencer virksomhederne har brug for, som en forudsætning for et vellykket samarbejde med eksterne kilder.

Dette studie skal således ses som et bidrag til den eksisterende viden om virksomhedernes brug af eksterne kilder. Der præsenteres en model, som tester effektiviteten af eksternt samarbejde, når flere eksterne samarbejdspartnere skal håndteres samtidigt. Desuden inkluderes virksomhedernes evne til at behandle information, som en central funktion for at få udbytte af samarbejdet. Evnen til at identificere de rette samarbejdspartnere og indsamle information fra dem, er nødvendigt for at relevante informationer sidenhen kan udbredes i hele deres organisation. Derudover er graden af et produkts nyhedsværdi for markedet inkluderet i modellen for at undersøge, om dette påvirker udbyttet af eksternt samarbejde. Denne model testes på en større database af danske og udenlandske virksomheder fra 19 brancher og giver dermed et bredt perspektiv på brugen af eksterne samarbejdspartnere.

I denne afhandling kortlægges kompleksiteten i en virksomheds samarbejde med mange eksterne kilder. Herigennem fremhæves de formelle og uformelle kompetencer en virksomhed skal besidde for at finde de rigtige partnere og trække oplysninger fra dem til brug i produktudvikling. Desuden påpeger afhandlingen vanskelighederne ved at samarbejde med eksterne kilder, når projektet er så nyt, at det er udenfor eksterne samarbejdspartneres referenceramme.

Supervisor:

Søren Salomo, Professor

DTU Management Engineering Produktionstorvet, building 424 DK-2800 KGS Lyngby, Denmark

Co-supervisors:

Carsten Schultz, Professor

Institute for Innovation Research Christian-Albrechts-Universität (CAU) Kiel, Germany

Karen Murdock, Assistant Professor

DTU Management Engineering Diplomvej 372, DK-2800 KGS Lyngby, Denmark

Table of Context

List of Figures

List of Tables

Chapter 1 - Introduction

> In 2013, MADE, Manufacturing Academy of Denmark, an organization and network created to advance knowledge sharing and collaboration, was launched to advance Danish manufacturing. MADE's members included firms, universities, technological institutes, and other stakeholders with an interest in research, innovation, and knowledge sharing within manufacturing. MADE's goal is to develop sustainable, technology-intensive manufacturing in Denmark through collaboration between private and public institutions. Since its inception in 2013, MADE's membership has grown rapidly, both within the private and public sphere, thereby increasing the number of opportunities that exist for joint developments between the affiliates. Over 40 Ph.D. projects have been launched in joint efforts between MADE members, and a multitude of other research-intensive collaborations are underway.

In many ways, the case of MADE highlights the importance and success of collaboration between firms, across industries, and over the boundary that often exists between public and private organizations. The possibilities and challenges faced by MADE resemble those that are faced by firms when they look beyond their immediate organization for information, knowledge, and ideas. The ongoing story of MADE highlights, from the perspective of a firm (and, for that matter, from the perspective of public institutions), the importance of collaborating externally with many different sources. It also shows that institutions are willing to invest in long term relationships if it can be demonstrated that such relationships increase the innovation capability of the firms. However, the MADE partnership also demonstrates that having an extensive collaboration takes commitment, not only in terms of direct investments in the projects, but also in terms of time and access. Integrating external sources into the NPD process is neither cheap nor easy, and a successful collaboration involves investing in finding out who has the information, knowledge, or ideas needed to bring a project to fruition. Furthermore, it involves developing structures and a culture that facilitate the flow of information across functional groups within the firm. Developing these capabilities is a challenge in and of itself, but that challenge is often compounded by resistance within the firm's organization to new and unconventional input.

1.1. Research Area and Relevance

1.1.1. The Importance of NPD Performance

Many firms find themselves under increased pressure to innovate in an intensified competitive market that demands more sophisticated and feature-rich products[1]. Intense global competitive pressure forces firms to focus on growth and profitability through new product development. Firms must cope with international markets that are both turbulent and diverse, and, in these markets, NPD plays a primary role in achieving a sustainable competitive advantage. Hence, firms recognize the importance of NPD. Firms are not only conscious of the importance of NPD, but also of the inherent risks in NPD related to the rising cost of the development process and the inherent uncertainty involved in developing something new to the market, which can lead to returns that are below expected levels.

1.1.2. The Role of External Sources in NPD

The market challenges outlined above have inspired many firms to look beyond the traditional closed model for NPD. Instead of relying solely on internal innovation efforts when bringing new products to the market, firms often look for sources of innovation beyond their boundaries [2]. Several factors have made this move towards external collaboration a viable source of input into the NPD process. Among these, the increased mobility of workers has facilitated the spread of knowledge and information across firms and industries. Another factor is the spread of faster and more advanced communications technology, which facilitates a level of sharing and processing of information that was previously unattainable[3]. These factors are eroding the closed innovation model, and have created a need and opportunity for collaboration outside the organizational structure of the firm. To this end, firms have begun to engage in collaboration with cus-

---

1 See H. Chesbrough & Crowther (2006).

2 See H. W. Chesbrough & Appleyard (2007).

3 Enkel, Gassmann, and Chesbrough (2009).

tomers, suppliers, competitors, public institutions, and many others[4]. This collaboration allows firms to collect information and knowledge that potentially can lead to the development of more market-relevant products, cheaper development and production, the setting of new industry standards, etc. In other words, collaborating with external sources has the potential to reduce the risks and limit the uncertainty associated with NPD.

Some of the world's largest firms, such as Proctor and Gamble and IBM, have made collaboration with external sources cornerstones of their NPD processes[5]. Both Proctor and Gamble and IBM have utilized external sources such as independent experts, customers, and research institutions to advance the development of their products and service offerings. Like the MADE initiative, the cases of P&G and IBM demonstrate the increasing prevalence of the practice of using external sources in NPD. However, focusing on the perspective of the firm, the case of MADE also raises several questions. How does collaborating closely with so many sources simultaneously bring about innovation capability? How does the firm develop the capabilities to manage complex collaborations? Does the degree of newness to the projected effect the firm's ability to effectively collaborate with a diverse group of external sources?

1.1.3. The Need for Information Processing

In the fields of research covering external collaboration in NPD, only a handful of studies investigate the effects of multiple external actors on large, cross-industry datasets. In effect, this means that our understanding of the effect of using external sources in NPD is rather piecemeal. The research available at this time provides a thorough picture of the diffusion and use of external collaboration within specific industries[6]. However, a more general understanding of the dynamics of collaborating externally across a wider

---

4 See Laursen and Salter (2006); Un, Cuervo-Cazurra, and Asakawa (2010); West and Bogers (2013).

5 See The love-in - http://www.economist.com/node/9928227

6 E.g., Foss, Laursen, and Pedersen (2011); Gassmann, Sandmeier, and Wecht (2006).

section of the economic landscape is missing[7]. Hence, from a research perspective, there is clearly a need for more investigation of external collaboration in NPD and of its performance effect when multiple external sources are involved. Furthermore, collaborating simultaneously with many external sources requires that a firm have specific information-processing abilities. Firms, therefore, need both formal information handling systems and informal methods of information sharing if they are to be able to handle the interactions. However, it appears that little attention has been given to the internal capabilities needed to integrate external sources of innovation, with the notable exceptions of *Herzog and Leker's (2010)* work on the impact of firm culture and *Cassiman and Veugeler's (2006)* paper on the effects of firm strategy.

This thesis sets out to test a model that examines the impact of external collaboration on new product development (NPD) projects in cases in which multiple external sources are involved simultaneously. The research takes its point of departure from the open innovation literature and aims to extend our current understanding of external collaborations by examining whether working with many external sources on the same project increases the likelihood of NPD success or proves to be detrimental to the development of new products, especially if a product can be characterized as something that has never been seen before, and therefore is outside the collaborators' normal frame of reference. Moreover, to increase its relevance for managers, the thesis includes an examination of specific internal firm capabilities that can facilitate the use of external sources in NPD.

In conclusion, while the research relating to firms' use of external sources in the NPD projects is a growing field, few studies have considered what happens to collaborative efforts when multiple actors are present simultaneously. The research also displays a lack of consideration for the firm-level capabilities needed to engage actively with external sources. Hence, the relatively disregarded concept of the intensity of collabora-

---

7 Notable exceptions include, but is not limited to Frenz and Ietto-Gillies (2009). Nieto and Santamaría (2007).

tion and its effect on NPD performance is becoming increasingly relevant — for NPD researchers as well as for practitioners.

1.2. Objective of Study

A review of the literature on the use of external sources of innovation in the NPD process reveals a lack of consensus concerning theoretical concepts, construct definition, and measurements of external collaboration in NPD. The majority of research into external collaboration has looked at the benefits of including external sources for innovation into the NPD process. External collaborators can then be said to mitigate the uncertainty involved in developing new products by providing the firm with knowledge and information that makes the NPD more market relevant[8]. However, research into customers as sources for innovation has been divided in terms of its value in promoting very innovative new products[9], and similar discussions currently prevail within research into suppliers as collaborators[10]. Both of these areas of research have shown mixed results, depending on the level of innovativeness involved and the extent to which external collaborators are integrated into the NPD project. This indicates that while external collaboration can improve NPD performance, integration of multiple external collaborators simultaneously might also prove to be a hindrance, especially when taking into account the level of market innovativeness involved in the NPD project. The more innovative the NPD project, the more challenging it is to gather relevant market information and disseminate it internally[11]. To the best of our knowledge, little attention has been given to the information processing capabilities needed to identify, acquire, and disseminate information from external collaborators in NPD.

In order to understand the structures and culture needed to adequate identify and inte-

---

8 Gassmann, Sandmeier, and Wecht (2006); Eric von Hippel (2009).

9 See Hamel and Prahalad (1993).

10 See Eisenhardt and Tabrizi (1995); Melander and Tell (2014); Petersen, Handfield, and Ragatz, (2005).

11 See Carlile (2002).

grate potential collaboration opportunities into the firm's internal NPD processes, I turn to market information processing theory[12]. When the firm is viewed as an information processing system, its ability to track changes in the marketplace, alert the organization about these changes, evaluate their potential effects, and act in anticipation of them is the key to sustaining a competitive advantage through NPD performance[13]. The combined effect of market information processing and external collaboration is, therefore, an important perspective to apply when looking at the impact of open innovation on NPD performance.

Finally, the concept of innovativeness is introduced to present the most dominant contingency affecting new product development. Innovativeness has a two-fold impact on NPD. First, it has been shown that level of innovativeness relates to performance[14]. Higher levels of innovativeness are associated with new products that offer something completely new to the market, or that open entirely new markets. In other words, the higher the level of innovativeness, the stronger the impact on NPD performance. Second, the level of innovativeness affects the level of uncertainty involved with NPD, which in turn has a direct effect on requirements for information processing. The higher the level of uncertainty, the harder it becomes for the firm to identify the most relevant collaborators, collect information from them, and disseminate that information throughout the organization.

The theoretical foundation of this thesis can be conceptualized along three dimensions (see figure 1): 1. Theories relating to the role of external collaboration in NPD. 2. The theory of market information processing as a central capability that the firm must possess to benefit from external sources in NPD. 3. The contingency of market innovativeness, which will impact how firms will need to adapt their use of external collaborators and their market information processing capabilities, depending on the level of novelty

12 See Hultink, Talke, Griffin, and Veldhuizen (2011).

13 See Veldhuizen, Hultink, and Griffin (2006).

14 See Kleinschmidt and Cooper (1991).

involved in their NPD project.

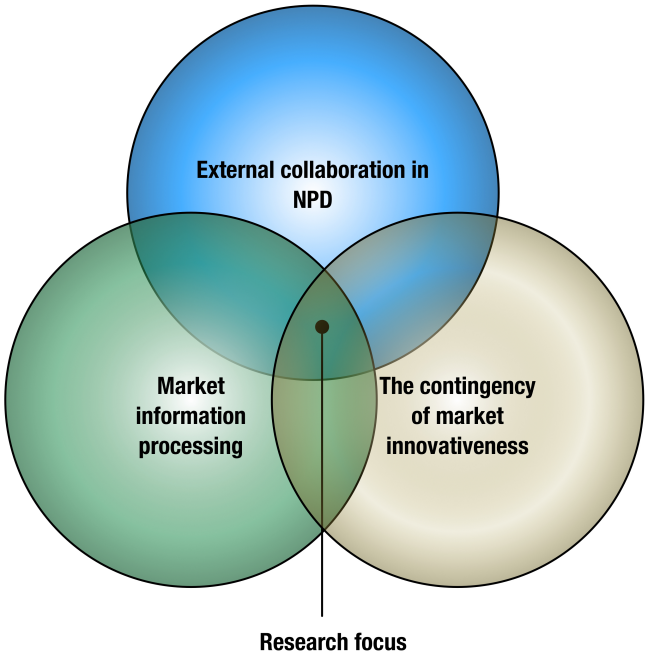


Figure 1. Research scope.

This thesis aims to meet the identified research gaps by focusing on three issues: First, this study examines the relationship between the intensity of external collaboration and market information processing. Previous research has examined the effect of external collaboration on NPD performance and found it to be positive[15]. Second, the role of market information processing in NPD has also been shown to positively impact performance[16]. As both issues seem to be connected, it remains relevant to assess how market information processing and intensity of external collaboration interact when they are applied in the NPD context. It is to be expected that market information processing competencies amplify the effect of external collaboration on NPD performance. Third, this final issue concerns the level of uncertainty involved with external collaboration in NPD projects. Since the ability to deal with uncertainty is a core concept of information processing theory, we include the level of market innovativeness in our model as a key

15 See Belderbos, Carree, and Lokshin (2004); Brettel and Cleven (2011); Danneels (2003).

16 See Cillo, De Luca, and Troilo (2010); Narver, Slater, and Maclachlan (2004); Zhou, Chi Kin Yim, and Tse, (2005).

contingency when dealing with NPD projects.

The objective of the study is, therefore, to answer the three following research questions:

- How does the intensity of collaboration affect NPD performance when multiple collaborators are involved?
- To what extent does a firm's ability to process information define the relationship between external collaboration and NPD performance?
- How does the contingency of market innovativeness affect NPD when multiple external collaborators are involved?

These three research questions will be answered with 11 hypotheses tested on a large, multiple respondent study from over 250 Austrian and Danish firms.

1.3. Research Structure

This study is divided into six chapters. In chapter 1, the introduction, research problem, and its relevance are explained. It is also demonstrated that this research fits into the existing literature on in-bound open innovation and the information processing capabilities of the firm. The main contributions this study makes to our existing knowledge are highlighted, and the objectives of the study are summarized in three overall research questions.

Chapter 2 lays out the theoretical framework for this research. First, the methodology for the literature review is presented along with three concepts central to the framing of this study—the firm, new product development, and innovation are defined. Second, the core research topic—external collaboration in NPD—is explored in its context within the academic literature. Third, information processing is introduced and discussed as a central firm-level capability for making NPD work. The fourth, and final, part of the chapter explores one of the central contingencies affecting NPD—innovativeness. Subsequently, prior research is discussed for all three constructs along with their relationship to NPD performance.

Chapter 3 provides the conceptual framework for the study and its research hypotheses. For the research hypotheses, Chapter 3 builds on Chapter 2 in terms of prior empirical evidence. Also, conceptual arguments are discussed and, whenever possible, deduced from underlying management theories. The hypotheses are derived by balancing the prior empirical evidence and conceptual arguments. Chapter 3 concludes with an overview of all research hypotheses.

Chapter 4 begins with an introduction to the overall empirical research design, including methodological considerations and a description of the data. This introduction is followed by an operationalization of the variables, based on the literature review and the hypotheses development. The last part of the chapter describes the data and tests the internal, convergent, and discriminate validity of the variables.

Chapter 5 demonstrates the results of the statistical analysis. The chapter begins with a recap of the research hypotheses and a short introduction into the underlying regression assumptions and verification of the regression analysis. The results of the hierarchical regression analysis itself are followed by a post hoc probing of the simple slopes for the interaction effects between the independent variables.

Chapter 6 discusses the results of the study and how they relate to the literature review. Implications for research are discussed, as are the study's limitations and its implications for future research. The chapter concludes with implications for practitioners.

Chapter 2 - Literature Review

In the following chapter the three central concepts of this research will be introduced and discussed based on previous literature on the topics. The chapter is divided into four parts. In this part, I go through the structure of the literature review, including an introduction to the methods used to collect relevant articles. I also use this introduction to define a set of terms that are central to the framing of this study, but not part of the overall analysis, e.g., the firm, which is the unit of analysis but not directly discussed.

The second part examine the concept of external collaboration in NPD. The different streams of literature that has dealt with the use of external sources of information in NPD are examined comparatively. This is followed by a closer examination of how the different types of external collaboration (e.i., customers, suppliers, competitors and universities) has been related to firm performance and an examination of the critique that has been raised about the validity of this research. This part of the chapter concludes with a review of previous research which has taken a similar large sample, cross sectional approach as I employ in this study.

In the third part of the chapter the concept of information processing is introduced. Two perspectives on information processing are examined; The concept of information as a firm capability and more specifically the benefits and challenges of collecting information from the market.

Finally, In the third part of the chapter, the concept of organizational contingencies is examined and innovativeness is presented as the core contingency in NPD. After completing this chapter the reader should have a clear understanding of the following:

- The current state of external collaboration in the NPD literature.
- The impact of specific types of collaborators i.e., customers, suppliers, competitors

etc. on NPD performance.

- The firm specific information processing capabilities needed for effective integration of external sources in the NPD process.
- The role of market innovativeness as both an indicator for NPD performance, but also one of the greatest sources of uncertainty NPD projects.

Overall, this chapter provides the theoretical foundation for the conceptual framework presented in chapter 3 and the empirical study laid out in chapter 4.

2.1. Literature Review Method

Systematic searches and formal summaries of the literature provided the means to identify and classify the results of all major studies relevant to the topic in question[17]. The search began by focusing on the different types of external collaborators a firm can engage in the NPD process and the intensity of those collaborations. This conceptualization of the external collaboration construct is in line with the concept of breadth and depth proposed by *Laursen and Salter (2006)*. For the review, Thomson Reuters Web of Knowledge (ISI) and Elsevier was searched for articles that had "open innovation," "external collaboration," "user driven innovation," or "co-creation" in the topic field. Furthermore, this search was extended with Boolean searches for "external," "open," and "NPD." The topic field includes the title, keywords, and abstract contained in the database. The broad definition for the search terms was used deliberately to capture as many relevant article as possible.

The initial search returned over 1,000 articles for further review. While not all journals are rated in the ISI index, this database is generally considered to be among the most comprehensive academic databases and one that represents the most prominent journals in the field. This screening narrowed the list for further review to approximately 180 papers. From these papers, 130 was selected, based on a review of their abstracts, for inclusion in this literature review (see Appendix for full list of reviewed papers).

---

17 See Higgins and Greeen, 2006.

While by no means a complete list of papers devoted to topics related directly to external collaboration in NPD, this group of articles provides a thorough overview of the state of research on the subject. This review method avoided bias toward any particular author and produced a list of representative references. Traditionally, within the natural sciences, the citations used indicate the relevance of a given paper. It is important to note here, however, that much of the research on external collaboration in NPD took place within the last decade and the literature is growing. Thus, a focus on the number of citations will exclude new and potentially groundbreaking research from the sample.

2.2. Definitions

This dissertation focuses on three concepts. The first is collaboration with external sources for NPD. This concept is embedded in the "Open Innovation" literature, with *Chesbrough (2003, 2006)* is one of the main proponents. To shed light on the firm-level capabilities needed to harness external sources for innovation, a second concept, information processing theory, is examined. The last central concept is innovativeness, the primary contingency affecting NPD projects. However, several other terms appear throughout the dissertation and while not central to the research topic, they do provide a frame of reference for analyzing and understanding the main concepts. With that in mind, brief definitions of the terms "firm," "new product development," and "innovation" are provided here.

2.2.1. The Firm

In this study, the term "firm" describes a for-profit organization engaged in market-related activities. In the most general sense, theories of the firm focus on the reason for the firm's existence, the way in which the boundaries between the firm and the market are defined and managed, and how the firm is organized for optimal performance. For the latter, researchers have examined why and how firms are organized from several

perspectives, e.g., a transaction cost economics perspective[18], a behavioral perspective[19], and a resource-based perspective[20]. While these approaches have provided valuable insight into the way firms organize and have even been applied in the context of external collaboration in NPD [21], the impact of external collaborators on firm-lead NPD projects is still something of a "black box."

This study approaches firms as open social systems that function primarily to manage information flows across organizational boundaries and between departments. This approach helps explain not only how firms respond to uncertainties in their environment but also the challenges associated with finding, collecting, and integrating the information needed to respond to uncertainties within the firm and its market[22]. This perspective is important because the way in which firms handle information has not appeared often in theories pertaining to external collaboration in NPD.

2.2.2. New Product Development

The term "new product development" or NPD has its roots in business and engineering research and is understood as the process of bringing a new product to market. It involves transforming a market opportunity into a product that can be launched. Several conceptual models exists to facilitate the NPD process, with the stage-gate model being

---

18 The traditional perspective in transaction cost economics is the cost of participating in the market, i.e., the cost of using the price mechanism. Ronald Coase (1937) laid out the basis for transaction cost theory as related to the firm by proposing that firms are the result of a given activity being too costly to achieve through the market and therefore cheaper through the organization of a for-profit enterprise. The concept of transaction costs has since been expanded to include any activity that includes the transfer of resources from one actor to another.

19 The behavioral approach to the theory of the firm includes a wide range of perspectives such as principal-agent theory, which is primarily concerned with the difference in motivations between firm owners and managers. Also, the limits of decision, or bounded rationality, traditionally fall under this literature.

20 In the resources-based view, the competitive strength of the firm lies in the bundling of its tangible and intangible resources. For a sustained competitive advantage, these resources must be heterogeneous and not perfectly mobile (Barney, 1991; and Peteraf, 1993).

21 e.g., Lambe, Spekman, and Hunt (2002); Brettel and Cleven (2011); Emden, Calantone, and Droge (2006).

22 See Tushman and Nadler (1978); Carlile (2004).

among the most widespread[23]. In this dissertation, the term is used in the most general sense to describe how the firm allocates resources for development of new market offerings. Its use does not refer to any specific model or method for managing specific activities.

2.2.3. Innovation

The conceptualizations of innovation vary across studies. Some classify it based on single aspects[24] and some in a dichotomous manner, e.g., incremental and radical innovation[25]. It is important to point out that innovation is not the same as invention. Innovation entails invention, that is, the creation of something new or a recombination of existing components, but adds some sort of exploitation. In most cases, the firm aims at an economic exploitation by bringing the innovation to market, thereby increasing market share, sales, and so on. However, even innovation that fails to be implemented in the way initially intended can still be exploited in other projects. Such innovations can be spun off as separate entities if there is a business case for them outside of the current organizational context or, at the very least, they can provide intellectual property or knowledge for future use. Classic innovation literature usually focuses, separately, on 1) what is new, 2) who it is new to, and 3) what level of novelty is involved.

1) The question "what is new?' usually relates to a product innovation or a process innovation. *Product innovation* involves an improved offering for customers that serves a previously unmet market need or an old need in a new way. A product innovation can therefore be aimed at existing customers or targeted toward opening markets or customer segments not previously reached by the firm's offerings[26]. *Process innovation* takes place most often within the firm[27]. The aim is to improve the efficiency of internal

---

23 See Cooper, R. G. (2008).

24 See Szymanski et al. (2007); Atuahene-Gima and Evangelista (2000).

25 See Ettlie et al., 1984

26 See Cooper, R. G. (1979).

27 Fritsch, M., & Meschede, M. (2001).

operational processes or methods. In recent years the concept of business model innovation has been thrown into the mix. *Business model innovation* involves changing the way business is conducted—for example, optimizing contractual frameworks or financial structures within the organization[28]. Product, process, and business model innovations can be undertaken independently. However, the successful launch of radically new product innovation projects usually requires significant changes to process and business models. One example often used in this context is Apple's introduction of the iPhone and iPad, which were new products aimed at creating a new market that required adjustments in production methods and new business models to deal with third-party developers and content providers.

2) The NPD literature dealing with innovation contains a great deal of diversity regarding the perspective from which the innovation is viewed[29]. In most studies, the perspective is that of the firm. However, others have looked at it with an eye toward what is new to the world[30], new to the costumer[31], new to the industry[32], or new to the market[33]. This study focuses predominantly on the market level, that is, how new the NPD is to the customer, the industry, or the market as a whole.

3) Within the literature, the level of novelty involved in NPD is often termed "innovativeness." Research in this area views this as "the degree of novelty involved in an innovation." From this perspective, a "radical innovation" would be one that, through technological or market means, creates a paradigm shift within one or more industries. Often a radical product innovation will open new markets and force a rethinking of existing business models. A radical innovation therefore often requires innovations in oth-

---

28 See Chesbrough, H., & Rosenbloom, R. (2002).

29 See Garcia and Calantone (2002).

30 See Song and Montoya-Weiss (1998).

31 See Cooper, RG. 1979.

32 See Colarelli O'Connor (1998).

33 See Kleinschmidt and Copper (1991).

er areas along with it. In the majority of studies used in this dissertation, the concept of innovativeness is used to describe the degree of novelty in an NPD. The measure commonly appears on a continuum that ranges from highly innovative products (having a great degree of novelty) to products with a low degree of innovativeness characterized by few changes to the existing offering. The concept of innovativeness in central to this PhD dissertation and will therefore be discussed in further depth at the end of this literature review.

2.3. External Collaboration within the Academic Literature

Extensive previous research has shown the importance of collaboration in NPD. *Hillebrand and Biemans (2004)*, for instance, demonstrated the importance of collaboration between business functions. Others have looked at cooperation among R&D and marketing[34], engineering and marketing[35], -manufacturing and marketing[36], and design and various other departments[37]. In addition to their extensive work on collaboration between departments, researchers have looked at the importance of cross-functional teams in NPD, highlighting the importance of having a wide variety of functions from within the firm contribute to NPD[38]. The research into collaboration with outside sources of innovation has received, comparatively, less attention. Furthermore, when talking about external collaboration, readers, practitioners, and academics alike are often confounded by the many associated terms thrown around. It is therefore prudent to begin by defining the different streams of literature that focus on external collaborators in NPD and then clarify their analytical assumptions. These assumptions relate to the unit of analysis used and the characteristics applied to external collaboration or related terms. It is therefore important to define what the concept of external collaboration entails, what its limitations are, and how it relates to the many other conceptualizations regarding the use of

---

34 See Griffin and Hauser (1996); Gupta and Wilemon (1998); Souder (1988).

35 See Lancaster (1993).

36 See St. John and Hall (1991).

37 See Adler (1995); Davies-Cooper and Jones (1995).

38 See Jassawalla and Sashittal (1998); Rochford and Rudelius (1992); Song et al., (1998).

external sources for generating ideas, information, and technical know-how. This makes the conceptualization of external collaboration in NPD used in this study very broad in the sense that it touches on many different streams of literature, with the "open innovation" literature being the most dominant. In this study, external collaboration in NPD is defined as collaboration with customers, suppliers, competitors, universities, and other external experts.

Over the past decade, several literature streams have examined what can be described as the fall of the closed innovation model and the rise of external sources of information for NPD. However, it would be imprecise to define research into external collaboration in NPD as the sole domain of open innovation literature. These streams share a common trait: they are critical of the traditional integrated model of industrial innovation as proposed by *Chandler (1977)* and *Freeman and Soete (1982)*. Within the integrated model, innovation is the sole domain of internal business functions and R&D units, while the more "open approaches" are concerned with the flow of information up and down the value stream. However, the streams also differ significantly in their view of the "openness" concept and their domain of research.

One of the most dominant streams of research, which relates closely to Chesbrough's definition of open innovation, is "user-driven innovation." *Eric von Hippel (1986, 2009)*, originated the term and is the main proponent for this line of research. User innovation and open innovation have a common point of departure in the distributed process of innovation. Both streams view the concept of "openness" as the firm sourcing externally generated ideas into its own NPD process. Both therefore view ideas and knowledge as something that should and do travel across the boundaries of the firm, which is a fundamentally different approach than that of the traditional integrated model.

User-driven and open innovation differ on several points. Open innovation takes a firm-centric view on innovation in general and NPD in particular, which echoes the integrat-

ed model view. User-driven innovation, on the other hand, emphasizes that innovations are often in the hands of the users and therefore outside the direct control of the firm that originated the product.

This difference leads to three areas where user-driven and open innovation take often widely differing positions[39]. First, user-driven innovation stresses that users will freely reveal their ideas and knowledge because as users of a given product it is in their interest to see their ideas for improvements and features implemented in future products, either by the firm or by other users. Open innovation, on the other hand, has emphasized the protection of intellectual property rights, since one of the primary ways to commercialize an idea or knowledge within this concept is to sell or license it. *Baldwin and von Hippel, 2014* succinctly sum up the two opposing positions on intellectual property:

> An innovation is 'open' in our terminology when all information related to the innovation is a public good - non-rivalrous and non-excludable. … It differs fundamentally from the recent use of the term to refer to the organizational permeability - an organization's 'openness' to the acquisition of new ideas, patents, products, etc., from outside its boundaries, often via licensing protected intellectual property (Chesbrough, 2003).

The second divergent characteristic that separates user-driven and open innovation is how they perceive ownership of control. In the open innovation literature, control is kept by the firm that originated the project. The incentive is to reap the economic returns from having such control. However, in much of the users as innovators literature, innovation is viewed as being under collective control. Likewise, in the community and co-creation literature, the entities involved, be it firms or individuals, share control and the benefits of the innovation.

The third aspect is the differentiation between monetary and social incentives as motivations for external sources of innovation to supply ideas and knowledge for the firm-centric NPD process. In the majority of cases involving open innovation, the monetary compensation is the primary way to reward participation by external sources in the

[39] See Piller, F. and West, j. 2014.

firm's innovation projects. User-driven innovation, in contrast, has focused on social incentives and highlighted that social norms and recognition are often more effective rewards. In this type of innovation, the user's experience of the product is among the driving factors and this type of incentive is therefore often used in non-commercial innovations. While the two approaches are distinct, this does not necessarily imply a dichotomous relationship. Rather, the two should be viewed as a continuum, with strictly monetary rewards at one end and purely social recognition at the other. Indeed, many NPD projects with external collaborators involved exhibit elements of both in the same project.

The three aspects discussed above are the dominant points of divergence within the user-driven and open innovation literature streams. These are the most dominant ones found when examining external collaboration in NPD. However, the following additional research streams also have looked at how external collaboration contributes to NPD processes[40]:

1. The **cumulative innovation** stream of literature deals primarily with how rival firms seek to increase market share and profits through innovation using the same technological or scientific platform, thereby advancing overall technological progress[41].
2. The **social innovation** stream focuses on communities. As previously mentioned, for this type of innovation activity, monetary rewards are not usually effective in encouraging participation. The information and idea generation in social innovation can occur in open and user-driven form. Communities can form around firm-centric open innovation activities while retaining the characteristic of a public good where reciprocity and the individual user experience drives participation[42].

---

40 See Bogers and West (2012).

41 See Nuvolari (2004); Murray and O'Mahony (2007).

42 See Lakhani and von Hippel (2003); Jeppesen and Frederiksen (2006).

3. The **co-creation innovation** stream highlights the dynamic between two different entities in an NPD process. Studies of this type of innovation often examine the relationship between the firm and users who want an active voice in creating new offerings[43]. Other have looked at co-creation stakeholder relationships such as alliances between rivals[44].

The focus of the three more specialized literature streams pertaining to external collaboration in NPD—cumulative innovation, social innovation, and co-creation innovation—all diverge in terms of the unit of analysis and the beneficiary of collaborative efforts. Cumulative innovation research emphasizes the firm in terms of the joint benefits of platform development. Social innovation research moves away from the firm to focus on the non-excludable public good. Co-creation innovation research predominantly examines user-centric collaboration in NPD[45].

As this discussion has demonstrated, many different literature streams exist that relate to external collaboration in NPD. These streams diverge in their perception of "collaboration" and "openness" in NPD. While they may not comprise a coherent body of work that can be unified under a meta-theoretical approach, their commonalities still suggest they can be characterized as a common "family" of research.

The NPD projects examined in this dissertation are controlled and monetized by the firm that originated the project, and the information they generate can therefore not be characterized as a non-rivalrous and non-excludable public good.

The dataset used for this study does not allow for a closer examination of whether social or monetary incentives were used in the selected collaboration efforts or how the firms' external collaborators perceived the efforts and benefits associated with the collabora-

---

43 See Prahalad and Ramaswamy (2000).

44 See Hagedoorn (2002).

45 See Bogers, M., & West, J. (2012).

tion. The focus of this study is therefore on how the firms' NPD projects benefit from the use of external collaborators. This places the theoretical framework here in line with that of the open innovation literature given the attention paid to the firm as originator, controller, and beneficiary of the NPD projects. Nevertheless, while the framing of this study is similar to that of the open innovation literature, it draws broadly in this literature review and subsequent analysis from every research stream on external collaborators in its description of the conceptual model (Chapter 3), the operationalization of variables (Chapter 4), and the discussion of results (Chapter 6).

2.3.1. Previous Research on Integration of External Collaborators

The information processing approach to external collaboration in NPD is arguably a new way of analyzing the internal capabilities that drive successful collaboration in NPD. A previous literature stream identified the firm's absorptive capacity as a key characteristic of successful integration of external sources of innovation. As mentioned in the contingency section of the literature review below, previous research into external collaboration has often failed to address the internal firm capabilities needed to make effective use of external collaboration. In the majority of the research on external collaboration in NPD, a core assumption is that organizations are open social systems that must respond to changes in their environments[46]. Since this environment always has the potential for instability, the organization must be able to track and adapt to these changes. In this regard, the literature on external collaboration and information processing are aligned in their focus on the purposive flow of information as a key capability for dealing with uncertainty. However, the majority of research into the integration of external collaboration in NPD has focused on the concept of absorptive capacity[47]. This literature examines the firm's internal R&D expenses as an indicator of its capability to process externally generated information and apply it in the NPD process. The research has shown that absorptive capacity, as measured by internal R&D investments, helps increase the benefits of external collaboration with regard to innovativeness and finan-

46 See Zahra and George (2002); De Jong and Freel (2010).

47 See Cohen & Levinthal, (1990); Spithoven, Clarysse, and Knockaert (2011); Veugelers (1997).

cial performance [48]. However, three problems exists when analyzing the effective absorption of external sources of innovation only as a measure of internal R&D expenditure or firm size.

- First, while the construct itself, as it is often presented in the literature, does give a measure of the level of resources devoted to innovation and thereby indicates the amount of resources available to internalize externally generated information and ideas, it does not address the internal environment the firm needs to effectively interact with external collaborators[49].
- Second, absorptive capacity does not explain the competencies needed for choosing external collaborators. Previous research has shown that there is a temporal element to absorbing information from external sources into the firm's NPD processes. Information must be acquired before it can absorbed or disseminated throughout the organization[50].
- Third, *West and Borges (2013)* found that while absorptive capacity did appear to amplify the significant and positive effect of external collaboration on performance, this could be the result of a substitution effect. In contrast to the traditional absorptive capacity construct, they suggest a competing hypothesis: that firms with a high degree of focus on and resources dedicated to internal R&D are less likely to have an interest in external sourced innovation[51].

The absorptive capacity literature does touch upon the capabilities needed for firms to effectively engage with external sources of information and innovation in the NPD process. This has not translated, though, into an effective multi-dimensional construct that can adequately explain the process from identification of collaborators to the generation and dissemination of information through the rest of the firm. In short, the theoret-

48 See Rothaermel and Alexandre (2009); Fabrizio (2009). De Faria, Lima, and Santos (2010).

49 See Bogers, M., and S. Lhuillery (2011).

50 See Veldhuizen et al. (2006).

51 See Laursen and Salter (2006); Ceccagnoli et al. (2010).

ical conceptualization of absorptive capacity seems sound, but the operationalization of the concept less so.

This study argues instead for and tests a model that proposes that the information processing capability of the firm directly relates to its ability to benefit from external collaborators in the NPD process. From a contingency perspective, the effectiveness of using external collaborators in NPD cannot simple be measured as the size of the firm or the amount of resources used on R&D. Rather, it becomes a question of the fit between the firm's information processing capability and its need for external collaborators, especially when faced with contingencies such as the level of innovativeness in the NPD project. This approach seems not to have been applied in the context of external collaboration in NPD. The first attempts to look at related problems with large enterprises goes as far back as *Allen (1971)*, who looked at the communication patterns for dispersed individuals involved in NPD and how this affected NPD success, all the way up to *West and Bogers (2013)*. The latter called for additional research into the firm characteristics needed for successful interaction with external sources of innovation that went beyond the absorptive capacity concept.

2.3.2. External Collaboration in the NPD context

> *Openness is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as firms look to advance their technology*[52].

Chesbrough's definition of openness is probably the one most commonly used across the literature addressing the use of external sources in NPD. Going further, *Gassman (2006)* identified five drivers of open innovation: 1) globalization, 2) technology intensity, 3) information technology, 4) new business models, and 5) knowledge leveraging[53].

1. Globalization has expanded the extent of the market, which allows for an

---

52 See Chesbrough, H. 2003.

53 See also Dahlander and Gann (2010).

increased division of labor.

2. The intensity of technological development has shortened product lifecycles which means the firm has to engage continuously in NPD to defend and expand its market position.
3. Technological gatekeepers may no longer be effective in R&D settings due to recent advances in information technologies that enable knowledge workers to access and disseminate information on emerging technological developments easily[54]. The need for external sources of innovation has stimulated questions about a definition of openness in NPD that emphasizes the permeability of firm boundaries, that is, an environment where ideas, resources, and individuals flow in and out of the firm.
4. Improved market institutions give firms new ways to capitalize from NPD projects. For example, intellectual property rights, venture capital, and technology standards allow firms to trade ideas and defend their market and technological positions. These institutions improve the capability for protecting NPD efforts but also increase the opportunity for collecting resources from the marketplace for the NPD process such as external funding and know-how.
5. Knowledge leveraging reflects changes in working patterns where professionals are unlikely to stay with the same firm throughout their career. Firms should therefore look for ways to engage with talents that might not wish or have the opportunity to be employed exclusively.

The advent of open innovation as proposed by *Chesbrough (2003, 2006)* and colleagues resulted from the deterioration of the closed innovation model, which required firms to develop a new way to handle their NPD activities. With the closed model for NPD becoming unsustainable across large sectors of industry, new opportunities for open innovation have been identified. *Baldwin and Von Hippel (2011)* compared cost structures in NPD and showed collaborating with external sources of innovation was often superior

54 See Whelan, Teigland, Donnellan, and Golden (2010).

to keeping NPD research internal. This is backed up by several studies that showed a positive, significant relationship between the degree of openness and the performance of NPD projects[55].

Previous research also found that collaborating with external sources of knowledge allows firm to discover new product features that would otherwise have been difficult for them to envision[56]; some collaborations even resulted in radical new product offerings[57]. *Frenz and Letto-Gillies (2009)* showed that the interaction between internal and external sources increases the innovation potential of the firm. These findings are supported by *Belderbos and colleagues (2010)*, who found that firms that engage intensively in NPD collaborations perform relatively stronger in explorative NPD activities than their counterparts.

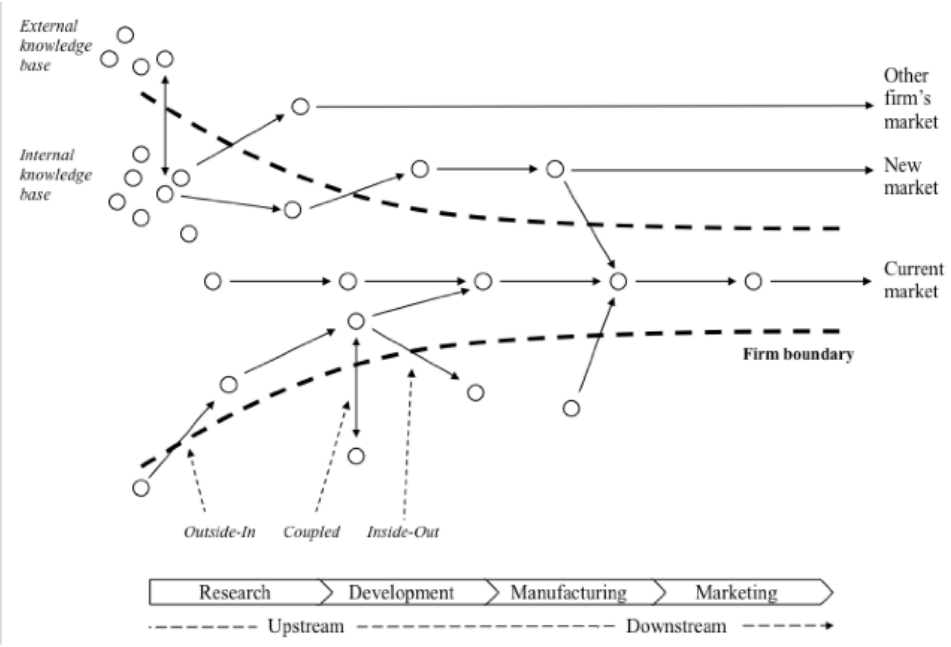


Figure 2. Open innovation model from Chesbrough 2003.

Despite these benefits, collaborating with external sources in NPD also poses challenges

55 See Belussi, Sammarra, and Sedita (2010); Mortara, Thomson, Moore, Armara, Kerr, Phaal, and Probert (2010).

56 See Almirall and Casadesus-Masanell (2010).

57 See Aylen (2010).

for the firm. When collaborating externally, it is necessary for the company to embrace a whole new set of subtle control techniques not based on hierarchical positions. The firm should also be able to motivate community members by providing intellectual challenges or some form of monetary reward[58].

Previous research identified three fundamental challenges for firms in applying the concept of open innovation: finding creative ways to exploit internal innovation, incorporating external innovation into internal development, and motivating outsiders to supply an ongoing stream of innovations[59]. The development and management of such relationships may, therefore, be one of the firm's most complex organizational activities. Managers and NPD team members must coordinate and integrate the resources of internal and external actors, each with their own agendas, embedded processes and structures, and formal and informal reporting systems, and do it in a market-relevant timeframe[60]. This has led researchers to propose that continuous support from top management is one of the most important key factors for implementing open innovation. Only a top-down strategy to open up the innovation process can increase overall employee awareness of its potential benefits. To this end, open innovation should be a result of an explicit strategy[61].

The literature notes three overarching approaches that firms use to manage external collaboration in NPD: 1) inbound open innovation, 2) outbound open innovation, and 3) coupled innovation.

The first and arguably mostly widely studied approach is inbound open innovation. The *Chesbrough (2003, 2006)* framework characterizes this approach as the purposive inflow of knowledge to the firm. It has also been characterized as a joint or collaborative

---

58 See Dahlander and Magnusson (2008).

59 See West and Gallagher (2009).

60 See Slowinski and Sagal (2010).

61 See Serhan, Albers, and Miller (2010).

engagement with external sources of innovation that have ideas or knowledge useful for the firm's internal innovation processes. *Dahander and Gann (2010)* proposed acquiring or sourcing, while *West and Bogers (2013)* identified obtaining, integrating, and commercializing as phases of the inbound open innovation process. The firm's business model determines which external inputs will be taken forward into the market. For inbound open innovation to work, the firm can employ a wide variety of tools to acquire and manage the incoming information and ideas resulting from its deliberate search for input.

Research has focused on different aspects of managing the purposive inflow of knowledge from external collaborators—for example, acquiring intellectual property licenses for use in its own NPD projects, using nondisclosure agreements to manage joint ventures or collaborative efforts, and funding startups and spinoffs to handle ideas not suited to the firm's current operations or business models.

In contrast, the outbound open innovation approach involves the firm offering its unused or underused ideas and assets to others for use in their business. Based on *Dahlander and Gann (2010)*, such activities can involve selling or sharing knowledge or assets to or with external sources. The business model that benefits from the idea or asset will differ significantly in most cases from that of the originating firm. Selling or licensing an idea or asset to another party to exploit is often the most viable path for the firm to capitalize on its investment. In addition to these strategies, the firm can also donate intellectual property and technology, create spin-offs, or seek corporate venture capital, corporate incubators, or joint ventures or other alliances[62]. As *Chesbrough and Rosenbloom (2002)* noted, discovery-oriented research often produces spillover technologies that lack a clear path to market. Finding a workable business model for these spillovers is a critical, often neglected dimension of creating value from technology.

---

62 See Chesbrough and Bogers (2014).

The third external collaboration approach links the inbound and outbound methods[63]. This "coupled" type of open innovation combines the outgoing and ingoing knowledge flows to develop and commercialize innovation in a collaborative context. The coupled open innovation model involves two (or more) partners that purposively manage mutual knowledge flow across their organizational boundaries through joint invention and commercialization activities. In theory, coupled open innovation can involve any combination of the activities that occur in inbound or outbound open innovation[64].

Since the focus here is on the use of external sources in NPD, the remainder of this literature review will concentrate on external collaborators providing information to the firm for NPD purposes, which aligns with the inbound open innovation concept.

2.3.3. Theoretical Critiques of Open Innovation

Because this study draws heavily on external collaboration, some of the conceptual issues raised regarding the theoretical validity of this concept must be addressed. Some studies argue that engaging outside sources of innovation is nothing new and that the inflow and outflow of knowledge and ideas have always been part of NPD. Furthermore, concerns have been raised about the validity of the factors said to have driven the rise of the open innovation model. Some even claim the open innovation construct is a "conceptual straw man" that seeks to frame a known phenomenon as a radical shift in how products and services are developed[65]. Another assertion regarding open innovation is that the trend toward it is reversing, that is, firms are returning to the larger internal R&D entities that dominated the innovation landscape previously[66]. Finally, some argue that the term "open innovation" itself hinders research into the changing paradigm of how knowledge flows through the NPD value chain because already existing constructs, such as supply chain management, provide a better framework for understanding

---

63 See Bogers and West (2012); Enkel et al. (2009); Gassmann and Enkel (2004).

64 Vanhaverbeke, W., & Chesbrough, H. (2014). In W. V. and J. W. Henry Chesbrough (Ed.), New Frontiers in Open Innovaion.

65 See Trott and Hartman (2009).

66 See Mowery (2009).

changes in innovation[67].

While these critical voices provide a much needed balance to the construct proposed by *Chesbrough (2003)*, they have failed to gain much traction among researchers. *Chesbrough and Bogers (2014)* argues that much of the critique revolves around definitions. Perceiving open innovation as a concept lacking academic rigor because it addresses an already known phenomenon is partially beside the point. The move from a closed integrated model to an open model for innovation is just that, a movement and not change of state. As noted previously, open innovation incorporates a wide range of activities and collaboration methods that encapsulate private and collective monetary models and combinations thereof. The question is not whether the phenomenon has been present before but whether it is becoming a prevalent mode of operation for firms engaged in innovation activities. This focus on a new mode of dealing with innovation also differs significantly from previous literature on supply chain management, which deals primarily with the movement of resources, components, and finished products through the value chain. There are several elements of open innovation that are not covered by this perspective. The whole intangible nature of the knowledge resources in question is an ill fit for supply chain management research, as is the diverse nature of potential stakeholders—e.g. universities, communities—in an open innovation process.

2.3.4. The Different Actors of External Collaboration

Following the presentation of the major schools of and points of contention with the external collaboration in NPD literature, this section reviews five of the most researched external collaboration actors identified from the literature: 1) customers, 2) suppliers, 3) competitors, 4) universities, and 5) external experts. The type of actor used for external collaboration is likely to affect the level of effort and resources needed and the type of results a firm can expect. An examination of the benefits and challenges identified in the literature as being associated with the different actors is therefore relevant here, as some overall perspective on the external collaboration of these actors.

---

67 See Groen and Linton (2010).

2.3.4.1. Collaboration with Customers

The integration of customer input into the NPD process is one of the most researched aspects of external collaboration. Customer collaboration has been linked to NPD performance in several previous studies. The most notable is the lead user research, of which with *von Hippel* is the most prominent[68]. Collaboration with customers has been linked to performance because customers can help firms identify opportunities to meet market needs in new, better ways or to satisfy previously unmet needs[69]. *Ciccantelli and Magidson (1993)* found the introducing consumers early in the NPD process provides a great source of knowledge, and a number of studies have identified customer integration as key to avoiding making design or marketing decisions that the market will receive unfavorably[70]. Collaborating with customers in NPD can therefore lead to more market-relevant NPD projects[71]. Other research supports these findings—for instance, *Poetz and Schreier (2012)* found that firms originating NPD projects valued customer ideas as being among the very best in terms of creating novelty and achieving customer satisfaction. However, *Callahan and Lasry (2004)* found that the importance of customer input increases with the level of market newness up to a point where the novelty of the NPD project becomes a hindrance for their participation at which point the effectiveness of customer input drops off. Customer collaboration therefore appears to have a harder time contributing to NPD for products that are completely new to the market or aimed at creating new markets. For technological innovations, however, customer input was found to be of greater and greater importance in relation to the level of newness, that is, it did not reach a cutoff point[72].

---

68 See for example von Hippel, 1986, 2009. also Urban and von Hippel, 1988.

69 See Li and Calantone (1988).

70 See Bercovitz and Feldman (2007); Lee, Park, Yoon, and Park (2010).

71 See for example Tether (2002); Knudsen (2007); Faems, Van Looy and Debackere (2005).

72 See Foss, Laursen, and Pedersen (2011).

Researchers have also looked at how firms organize when integrating customers in the NPD process. Firms that attempt to leverage customer knowledge in the context of NPD must structure their internal organization appropriately to support it. The new organizational structures and processes that can achieve this include, in particular, the use of intensive vertical and lateral communication, establishing rewards for employees who acquire and disseminate information, and creating high levels of operational autonomy.

Other studies have pointed out that firms that rely heavily on customers for ideas and knowledge in the NPD process risk focusing on a small segment of customers instead on broader, generalizable market needs or focusing too much on the current technology platform and so missing important technological developments[73]. Others found that managers have a high degree of interest in integrating customers into their NPD process but also have concerns regarding potential drawbacks such as a lack of secrecy concerning new product features and a tendency to produce incremental innovations rather than radical ones[74]. However, such opposing results and conceptualizations of problems with costumer integration do not dominate the academic research into customers as collaborators in NPD. The predominant findings appear to support the beneficial impact of customer collaboration in NPD[75].

2.3.4.2. Collaboration with Suppliers

Researchers have identified several benefits from including suppliers in the NPD process. For example, since communication channels already exist between suppliers and buyer firms, transferring information from the suppliers to the buyers' NPD project teams is often comparatively easier than with other external collaborators. In addition, these entities are often characterized by their flexibility, speed, innovation, and ability to

---

73 See Knudsen (2007); Nieto and Santamaria (2007).

74 See Bartl, Füller, Mühlbacher, and Ernst (2012).

75 See Callahan, J., & Lasry, E. (2004).

adjust smoothly to changing market conditions and new strategic opportunities[76]. Consequently, they often have great insight into products being offered by the firm and can be a source for ideas and technological input. As part of the firm's supply chain, they can also assist in identifying problems there early[77]. Indeed, supplier collaboration in NPD projects can reduce the complexity of the NPD process through the ideas produced, the direct technical support given, and the early supply chain considerations provided within established communication lines. Furthermore, suppliers are often willing participants in the NPD process as they stand to benefit from any "spill-over" effects that might influence future research and development[78].

For this type of collaboration to function efficiently and effectively, the firm must consider not only the capabilities of the supplier but also the culture. The culture will affect the buying firm's ability to interact with the supplier effectively. Careful attention to selecting and/or using a supplier for collaboration is important regardless of the NPD development stage at which the supplier will be integrated and regardless of responsibility the supplier will be assigned in the project. The findings also highlight two important types of input that purchasing firms might seek from a collaborating supplier: the supplier's assistance in determining appropriate technical metrics and project targets and a mutual agreement with the supplier on the nature and scope of these targets. These have been shown to be key elements in NPD project team effectiveness[79].

Another important element appears in research by *Li and Vanhaverbeke (2009)*, which suggests that it is important for firms seeking to generate pioneering NPD information to search for suppliers from different industries. Finding such firms gives the NPD firm access to various complementary external information sources. In addition, researchers have found that collaboration with suppliers from the same or adjacent countries re-

---

76 See Dittrich and Duysters (2007).

77 See Handfield, Ragatz, Petersen, and Monczka (1999); Un, Cuervo-Cazurra, and Asakawa (2010).

78 See Lau, Tang, and Yam (2010); Petersen, Handfield, and Ragatz (2003).

79 See Petersen, Handfield, and Ragatz (2005); Schiele (2010).

quires fewer resources because the proximity and common language, where present, facilitate easier communication and coordination.

The early involvement of suppliers in the NPD process has been identified as one of the most effective types of external collaboration in terms of contributions made to a firm's performance[80]. The increasing dependency of most firms on an expanding base of suppliers means the management of these relationships is of great importance. To be effective, such relationships should be changed from the traditional arm's-length purchasing agreement to integrated partnerships. When the supplier of a critical component is not a close partner in the design process, the product can experience major schedule problems and be of lower quality. These problems are further complicated if the supplier relies on others to purchase parts to be incorporated in its product[81].

Issues that arise with supplier integration into the NPD process often relate to tier structure, level of responsibility for design, specific responsibilities in the specification setting process, the timing of involving suppliers in the process, inter-firm communications, intellectual property agreements, the level of supplier involvement with the project team, and the alignment of organizational objectives with expected outcomes [82]. *Brettel and Cleven (2011)* add that the risks related to collaboration with suppliers may include the firm originating the NPD project becoming too dependent on supplier-held competencies and resources or that information sensitive to the NPD process is disseminated to the competitors buying components from the same supplier.

2.3.4.3. Collaboration with Competitors

Coopetition, that is, collaboration with competitors, is challenging yet potentially helpful for firms in addressing major technological challenges, in facilitating benefits for

---

80 Li and Vanhaverbeke (2009); Gassmann, Sandmeier, and Wecht (2006).

81 See Bonaccorsi and Lipparini (1994).

82 See Brettel and Cleven 2011.

partnering firms, and in advancing technological innovation. Moreover, coopetition between giants causes subsequent coopetition among other firms and results in advanced technological development[83].

Involving competitors in the NPD process is a sensitive affair and viewed as counterintuitive by many. As *Dahlander and Gann (2010)* identified, the main fear for firms considering external collaborators in their NPD process is that their intellectual property will be exploited by others. Sharing knowledge, information, and ideas with competitors might appear to be the last activity a firm engaged in NPD processes should undertake. However, if handled correctly, collaboration with competitors can generate supplementary knowledge and help develop the capabilities needed for NPD. Collaboration between rivals therefore allows firms to measure their technological capabilities against their direct competitors. Among other benefits, this again can help them differentiate themselves from each other.

In the case of incremental innovations, a firm-level focus on information transfer, knowledge sharing, and learning will affect coopetition positively, as will an appropriate emphasis on knowledge protection[84]. In other words, when incremental developments are pursued in collaboration with competitors, firms should not only seek to exchange knowledge for joint value creation but also remember to secure their firm-specific core knowledge and information to stay competitive.

On the other hand, when the firm is pursuing radical innovation with its rivals, it should place the heaviest emphasis on protecting existing core knowledge and emerging novel innovations and market opportunities. Not divulging its capabilities in information acquisition is also beneficial in these cases. In any case, the full benefits of information exchange only appear when the firm's knowledge protection mechanisms are sufficient-

83 See Gnywali and Park (2011).

84 See Gnywali and Park (2011).

ly strong to allow a safe, controlled knowledge exchange between rivals[85].

Collaborating with competitors for NPD can appear a paradoxical exercise given the need for information and knowledge sharing and, at the same time, knowledge protection. This paradox is mirrored in much of the research on the topic to date. *Belderbos et al., (2004)* found that collaboration between competitors can produce incremental and radical innovations. *Nieto and Santamaria (2007)* found the opposite, while *Knudsen (2007)* and *Miotti and Sachwald (2003)* found no effect on performance from competitor collaboration. What is more, *Un, Cuervo-Cazurra and Asakawa (2010)* found that collaborations with competitors appear to harm NPD. The usefulness of competitor integration in the NPD process is therefore open to question and ongoing debate, with little consensus regarding its viability in or value to collaborative NPD.

2.3.4.4. Collaboration with Universities

Universities are a constant source of scientific research, which under the right circumstances can be used in NPD projects. University collaborations can be leveraged in NPD projects to gain access to specialized equipment, knowledge, and technical support. Collaboration with universities can involve formal joint R&D agreements or informal knowledge exchange. Collaboration with universities is often seen as a relatively safe way to exchange knowledge and information because of the low probability of unintended dissemination of sensitive information to competitors[86]. Greater external collaboration with universities has also been found to provide benefits in terms of the pace of searching for new innovations. At the same time, it does not independently affect the quality or novelty of NPD outcomes[87].

Research regarding collaboration with universities in NPD has produced a number of observations. For example, university resources are often used for basic NPD research

---

85 See Ritala and Hurmelinna-Laukkanen (2013).

86 See Bercovitz and Feldman, 2007.

87 See Fabrizio (2009).

or for projects that are far away from entering the market. Several researchers have found that NPD projects increasingly rely on some sort of collaboration with universities[88]. *Tether (2002)* argued that collaboration with universities is less costly than other potential collaborations. *Cassiman and colleagues (2010)* found that basic projects are likely to be developed through formal cooperative agreements with universities but that such projects tend to be strategically less important. For strategically more important projects, in particular those where the knowledge to be developed is especially novel to the firm, the firm is more likely to contract formally with a university for a specific deliverable, usually due early on in the project. Interestingly, the firm's size seems to moderate the effect of the firm-university collaboration. Small firms apparently can draw on their university-based associations to leverage internal NPD resources to a greater degree than large firms. In this regard, the advantages of university collaboration appear to offset some of the benefits related to economies of scale that large firms possess[89].

The view regarding the prevalence of university collaboration varies within the literature. *Cohen et al., (2002)* found that a third of the firms they surveyed used public-generated research in their NPD. However, *Laursen and Salter (2004)* observed that only a very limited number had established any kind of collaboration with universities. Studies have also revealed that aligning the interests in the university-firm relationship can prove challenging. Universities are primarily concerned with creating knowledge for publication and education. Firm-driven NPD activities center on capturing knowledge that can be exploited for competitive advantage. This creates what *Bruneel, D'Este and Salter (2010)* termed orientation-related barriers to collaboration. These barriers, along with transaction-related barriers (which refer to intellectual property ownership conflicts), are the primary obstacles to successful collaboration between universities and firms. Despite these insights, relatively few solutions for reducing these barriers for collaboration appear in the literature.

---

88 See Tijssen, 2002.

89 See Link and Rees (1990).

2.3.4.5. Collaborating with other External Sources

While customers, suppliers, competitors, and universities are the most frequently studied actors in the external collaboration literature, they are not the only ones firms can engage in external collaboration. Other examples include engineering consultancies, specialized startup firms, retail and distribution firms, and other public research institutions[90]. These are all potential input sources for the NPD process if the context warrants such integration. *Tether (2002)* argued that external experts, as mentioned above, can provide the firm with specialized knowledge, assist directly in development as additional workforce, or offer advice on NPD process and workflow optimization[91].

Other branches of the external collaboration literature have looked at phenomena such as innovation intermediaries[92] and crowdsourcing[93] (an umbrella term covering a wide variety of different activities). Methods for engaging innovation intermediaries include reaching out through online platforms[94], conducting solicited innovation with regard to consumer goods[95], or reaching out through firm-hosted communities[96]. *Afuah and Tucci (2012)* pointed out that tools such as crowdsourcing help firms gain access to information farther removed from their normal operations[97].

2.3.4.6. Summary on Different Types of External Collaboration

The research on external collaboration is varied and covers a wide variety of firm and

---

90 See Brettel and Cleven, 2011; Weerd-Nederhof and Fisscher (2003).

91 see also Knudsen (2007); Droge, Stanko, and Pollitte (2007).

92 See Benassi and Minin (2009).

93 See Ebner, Leimeister, and Krcmar (2009); Poetz and Schreier (2012).

94 See Jeppesen and Lakhani (2010).

95 See Dobgson, Gann and Salter (2006).

96 See Jeppesen and Frederiksen (2006); Terwiesch and Xu (2010).

97 See Holmes and Smart (2009).

collaborator-centric activities. The majority of this research appears in the past decade, with 24% being published before 2005. In this study, 53 of the 126 studies reviewed were conceptual or qualitative studies, 67 were quantitative, and six used mixed methods. Despite the diversity in research focus and methods, the majority of the literature on external collaboration focuses on specific types of collaboration, e.g., customers, and often on very specific industries, e.g., open source software. The overall picture of external collaboration in NPD is therefore more akin to a collage of snapshots than a comprehensive picture of its overall effect on the economy in general. It is therefore important to examine the studies that attempt to patch this knowledge gap closely to see how they evaluate the impact of external collaboration on NPD across a much broader spectrum of industries and while measuring several types of collaboration at the same time.

2.3.5. Quantitive Research on External collaboration

The diversity within the field of external collaboration in NPD makes drawing general conclusions from the literature challenging. Nevertheless, some overall tendencies appear. In general, most studies in the sample focus on one aspect of external collaboration (e.g., collaboration with customers) and more often than not test this relationship on a limited number of firms within a single industry. Even studies with larger datasets often focus on a specific industry or one type of collaboration. The narrower focus of most research on specific industries or firms has provided many valuable insights into the effectiveness of different types of external collaboration under a wide variety of circumstances in widely different industries[98]. Nevertheless, comparatively few of the studies reviewed for this study investigate external collaboration in NPD using a methodological approach similar to the one employed here: a large cross-sectional framework. Moreover, the focus on a single type of collaboration in the NPD process fails to take into account that firms often engage with several types of collaborators simultaneously. This can have a profound impact on the perceived effectiveness of external collaboration in NPD. In the interest of examining the literature that used a large cross-sectional

[98] e.g., Foss, Laursen, and Pedersen (2011); Sieg, Wallin, and Von Krogh (2010); Nicholls-Nixon and Woo (2003).

dataset and looked at multiple collaboration partners simultaneously, a second review of the sample of papers was conducted. This review identified 19 papers for further examination. These matched the cross-sectional and collaboration criteria in their conceptual and methodological approaches. The table below illustrates the area of interest, variables used and results for the papers analyzed in this section.

Author	Research Question	Theory	Sample	Independent variables	Dependent Variable	Results
Belderbos, R., Carree, M., and Lokshin, B. (2006).	Engagement in R&D collaboration.	R&D collaboration.	1992 firms form Netherlands community innovation survey (CIS).	Competitor, supplier, customer University cooperation; Spillovers; R&d intensity; investment group; Firm size.	Labor productivity.	Benefits of collaboration depends firms size and strategy. Collaboration with customers enhances market acceptance and competitor and university collaboration. Small firms lower effect due to high cost and complexity of multiple collaborators.
Belderbos, R., D. Faems, B. Leten, and B. van Looy. (2010)	Analysis technological solitary versus collaborative strategies on financial performance.	Organizational Learning; R&D collaboration.	168 firms in Japan, US, and Europe from 5 different industries.	Patents; R&D Assets; exploration share; Collaborations.	Firm performance	The value enhancing effect of using external collaborators can be offset by the complexity involved in collaboration.
Brettel, M., & Cleven, N. J. (2011).	Use of external knowledge in NPD vary across firms.	Resource-Based View	254 firms in technology intensive industries.	Customer, supplier, competitor, university, independent expert collaborations; Technical orientation; learning orientation; Risk willingness.	NPD performance	Finds positive relationship with customers,suppliers, universities. Negative relationship with competitors and external experts.

Faems, D., de Visser, M., Andries, P., & Looy, B. Van. (2010).	Examines value-enhancing and cost-increasing effects of technology alliances on financial performance	Open innovation.	305 firms from the Belgian Community Innovation Survey (CIS-4).	Diversity of technology alliance portfolio; internal innovation effects; product innovation performance.	Firm performance;	Confirms the internal and external innovation happens in conjunction. However, firms should be careful with the cost of intensifying the technology alliance portfolio.
Faems, D., Van Looy, B., & Debackere, K. (2005).	Impact of inter-organizational collaboration NPD performance of firms.	NPD collaboration.	221 firms from the Belgian community innovation survey (CIS-2).	Indicators for effectiveness of innovation strategy; Indicators for collaboration.	Turnover	More collaborators leads to new and improved products. Diverse collaborators leads to diverse innovation outcomes.
Frenz, M., & Ietto-Gillies, G. (2009).	Explores two categories of knowledge sources in NPD: internal R&D and external collaboration	Open innovation; knowledge transfer;	679 observations with 171 uncensored observations. (CIS-3) (CIS-2)	R&D expenditure; Bought-in R&D; Innovation cooperation; Cooperates internationally.	Innovation sales	intra-company knowledge sources, own-generation, and bought-in R&D matter in innovation performance, the benefits of joint innovation efforts in the form of cooperation are less clear.
Hagedoorn, J. (1993).	How does firm alliances for NPD impact innovation efforts.	Alliances; Innovation management.	4192 strategic alliances.	Motives for strategic alliances.	Complex modes of contractual arrangements.	Sector, maturity, type of partnerships impact which and how many resources needs to be devoted.
Keupp, M. M., & Gassmann, O. (2009).	Firms use of external collaborators for NPD result of internal weaknesses.	Open Innovation	2300 firms from the Swiss innovation survey.	information and capabilities related impediments; Risk-related impediments.	Depth and Breath of open innovation.	This article identifies four 'archetypes' of firms that differ significantly regarding the breadth and depth of open innovation and the importance of impediments. 1. professionals. 2. Explorers, 3. Scouts and 4. Isolationist.

Lau, A. K.W., E. Tang, and R. C. M. Yam. (2010).	examines the impact of key supplier and customer integration processes on product innovation as well as their impact on product performance	Innovation Management; External collaboration	251 manufacturing firms in Hong Kong.	Information sharing with suppliers and customers.; Product co-development with suppliers and customers; Market certainty; innovativeness.	NPD performance;	Firms codevelop new products only with new customers and lead users instead of current ones for product innovation. Also, information sharing and product co-development affect performance directly and indirectly.
Laursen, K., & Salter, A. (2006).	Investigates search strategies for NPD.	Open Innovation; Innovation search.	2707 manufacturing firms from the UK community innovation survey (CIS).	Breath of collaboration; Depth of collaboration; R&D intensity.	NPD performance.	External sources can help firms gain and exploit innovation opportunities. However, over-search a problem because efforts can exceed value.
Lee, S., Park, G., Yoon, B., & Park, J. (2010).	How does the concept of open innovation apply to SMEs.	Open innovation.	2414 firms from the technology innovation survey in Korea.	barriers to innovation; Information use; collaborations.	SEM (structural equation modeling)	Networking enhances the effectiveness of external collaboration in NPD.
Miotti, L., & Sachwald, F. (2003).	What determines choice of external partners in NPD.	Resource-Based View; knowledge transfer.	2378 firms from the French version of European Community Innovation Survey (CIS-2).	Sectoral variables; firm characteristics; Obstacles to innovation; Public funding.	Co-operation.	Trans-Atlantic co-operation more effective than intra-european co-operation for French Firms.
Nieto, M. J., & Santamaría, L. (2007).	How different types of networks effect NPD and degree of novelty.	R&D collaboration.	1300 Spanish firms.	number of years collaborating; Collaboration with Research organizations; Client, suppliers, competitors; Collaboration across partners.	Innovativeness.	Found that customers, suppliers and university collaboration has positive impact on NPD while competitors do not. The impact is greater when the network has different types of partners.

Tether, B. (2002).	Patterns of cooperation in NPD.	Collaboration in NPD	1275 firms from the UK's version of the European community innovation survey (CIS-2).	R&D and co-operation; Co-operation to reduce difficult in NPD; Type of innovation.	Co-operation with different partners.	Majority of firms still do NPD without formal collaboration. More likely if high levels of innovativeness involved,
Tijssen, R. (2002).	The prime aim was to examine what actually happens in innovation practice through patent data.	Innovation Management; External collaboration	93 dutch firms, universities and research institutions	Internal knowledge; external R&D; Other information sources.	Patent data	The outcome confirms that several, more or less equally influential factors seem to be determining the knowledge creation and transfer processes leading to successful technical inventions.
Un, C. A., Cuervo-Cazurra, A., & Asakawa, K. (2010).	The relative impact of different types of external collaboration on R&D.	Open innovation.	781 Spanish firms.	R&d collaboration with Universities, suppliers, customers, competitors; R&D with combined collaborations.	Product innovation; Number of products innovations.	Both supplier and university research positively impact product innovation, while competitors have a negative impact and customer collaboration has no effect.
Van de Vrande, V., de Jong, J. P. J., Vanhaverbeke, W., & de Rochemont, M. (2009).	Explores open innovation in SMEs.	Open innovation	605 firm in the Netherlands.	Technology exploitation; Technology exploration.	Incidence and perceived trends	The larger the firm the more engaged in open innovation. SMEs also use open innovation primarily for market related activities.
Zeng, S. X., Xie, X. M., & Tam, C. M. (2010).	Explores the impact of collaboration networks on NPD performance.	Cooperation networks	137 SMEs in China.	Inter-firm cooperation; Cooperation with government agencies, Intermediary institutions; research organizations.	NPD performance.	Positive relationship between NPD performance and collaboration with other firms, intermediaries and research institutions.

Table 1. Overview of Research on External Collaboration in NPD based on large data samples.

Testing the effectiveness of external collaboration in NPD over a wide cross-section of firms and industries avoids the potential bias of examining this phenomenon within a single entity and industry with specific characteristics that might be conducive or averse to collaborating with outside sources of innovation. However, not all the studies in the 19 paper subsample handled their cross-sectional approach in a statistically optimal manner. For example, *Nieto and Santamaria (2007)* looked at the role of different types of collaborative networks in achieving product innovations and their degree of novelty within 1,300 firms. *Miotti and Sachwald (2003)* researched how R&D partnerships affect the access and ability to build global R&D networks using the French version of the European community innovation survey (CIS-2). Likewise, Tether, 2002 studied external collaboration arrangements for innovating firms by employing the United Kingdom's version of the second European community innovation survey (CIS-2). While these studies use large samples and take a broad perspective on the use of external collaborators in NPD, they have methodological issues. Both *Nieto and Santamaria (2007)* and *Miotti and Sachwald (2003)* included firms in their large samples that had no innovation activities. This could bias results, as acknowledged by earlier studies on the behavior of innovative firms[99].

The overall results from the large-sample studies paint a complex picture of the effectiveness of external collaboration in NPD. Tether, 2002 found that, while external collaboration is becoming more prevalent, the majority of firms still rely on internal NPD and have not formalized external collaboration. At the same time, several studies based on large samples showed a link between external collaborators and NPD or firm performance. *Belderbos, Faems, Leten, and van Looy (2010)*, for instance, explored how in-house development versus collaborative strategies affected firm performance. Their study found that, while external collaboration in NPD projects positively influences performance, this effect can be offset if the complexity of collaborating becomes too great. Moreover, *Faems, de Visser, Andries, and Looy (2010)* looked at the value-enhancing

[99] See Tether (2002).

and cost-increasing effects of technology alliances on financial performance. This paper found that the costs of maintaining such an alliance can outweigh the potential benefits of engaging in alliances. These results confirm previous work by *Laursen and Salter (2006)*, who investigated external innovation search strategies and found that external sources can help firms explore and exploit innovations but with the caveat that conducting this search can become more costly than the potential exploitation[100]. *Keupp and Gassmann (2009)* examined *Laursen and Salters' (2006)* concept of depth and breadth of external collaboration further and identified four different types of collaborators in firm-initiated NPD whose depth and breadth of collaboration vary greatly, as does the benefit derived from using external sources. Other studies have focused on which external collaborators have the greatest impact on NPD. The majority of these articles found that using customers, suppliers, and universities as collaborators in NPD projects provided benefits[101]. Another group of studies has focused on firm characteristics—such as strategy, size, industry, and maturity—as determinants of their ability to benefit from external collaboration in NPD[102]. Firm size in particular seems to play an important role in the relationship between external collaboration and performance. *Van de Vrande, Jong, Vanhaverbeke, Rochemont (2009)* found that the larger the firm, the more engaged in open innovation it is likely to be and that the smaller firms that employ external collaborations primarily use them for market-related activities. This is supported by previous research by *Belderbos, Carree, and Lokshin (2006)*, who found that smaller firms have a harder time benefitting from multiple external sources of innovation due to the high cost and complexity of working with multiple collaborators.

Previous studies have confirmed the benefits of using customers as sources of innovation in NPD. This relationship has been widely examined in the user-driven and co-creation innovation literature using smaller or narrower samples[103]. The majority of past

---

100 See Li, Vanhaverbeke, and Schoenmakers (2008).

101 See Nieto and Santamaría (2007); Brettel and Cleven (2011); Zeng, Xie, and Tam (2010).

102 See Belderbos, Carree, and Lokshin (2006); Hagedoorn (1993).

103 e.g., Piller and West (2014).

research with large datasets has expanded on these results and found partially confirmatory aspects and outright conflicting results. For instance, a study of 251 manufacturing firms in Hong Kong found that products codeveloped with suppliers improve performance, mediated by innovation. However, firms cannot improve their product innovation by sharing information with current customers and suppliers as they develop new products[104]. In contrast, *Un, Cuervo-Cazurra and Asakawa (2010)* found that collaboration with suppliers and universities positively affected product innovation, and, interestingly, that collaboration with customers had no impact and collaboration with competitors was negative. To explain these results, the authors draw on knowledge-based theory, which indicates that the narrower the knowledge base provided by collaborations, the easier the interaction. This focus on the firm-level capabilities needed to make external collaboration work is prevalent within the subsample. In addition to the findings by *Un, Cuervo-Cazurra and Asakawa (2010)*, information sharing has also been identified as a key capability for successful NPD with external collaborators[105]. Likewise, *Keupp and Gassman (2009)* looked at the impediments within the firms' established capabilities to making innovation work internally, thereby driving it toward external collaboration.

2.3.6. Summary of External Collaboration

This review of the use of external collaboration in NPD has revealed two important deficiencies in our knowledge

First, The effectiveness of external sources in new product development, therefore, appears to be very dependent on context rather than a universally applicable tool in NPD. In other words, the effectiveness of external collaborations is dependent on the complexity of the collaboration undertaken. *Laursen and Salter's (2006)* framework measured the depth and breath of external collaboration for NPD. However, an argument could be made that the depth and breath constructs are two aspects of a more general construct of collaboration intensity. How many types of collaborators is involved in

104 See Lau, Tang, and Yam. (2010).

105 See Lau, Tang, and Yam (2010).

NPD (breath of collaboration) and how much does the firm draw on the external sources for knowledge (depth of collaboration) are two aspects of the intensity of external collaboration. When examining the effect of the intensity of external collaboration on NPD performance the use of a single measure allows for a direct view of the impact of the combined effect of all external collaboration activities across NPD. As the prevalence of using external sources in NPD increases so does the need to what see what the intensity of external collaboration has on the NPD process. In other words, a single measure provides a view of how the collaborating closely with several sources simultaneously impacts NPD performance. This perspective can help clarify if the increased use of external sources in NPD is beneficial or detrimental to the NPD process. The studies reviewed have indicated many possible benefits of collaborating externally, from ideas, information and knowledge[106]. *Laursen and Salter (2006)* extended previous research by *Katila and Ahuja, (2002)* which discussed the problem of over-searching when looking for innovation opportunities. The concept of over-search involves expending more resources on establishing and maintaining collaboration efforts than the subsequent development is worth. Furthermore, searching far away from the firms own knowledge base could also make the integration of input from external sources more challenging for the firms conducting the NPD project[107].

Second, it appears that a lack of consensus exists concerning the firm-level capabilities needed to integrate sources outside the firm successfully in the NPD process. *Belderbos, Carree, and Lokshin (2006)* and *Hagedoorn (1993)*, for example, examined characteristics of the firm such as size, but little research has been conducted on the actual internal capabilities needed to engage effectively with external sources. However, *Chesbrough's* central definition of open innovation as the purposive inflow and outflow of information between the firm and its external sources helps clarify what type of capability might be needed for handling external sources in NPD. Hence, our understanding of how to bene-

106 See Chesbrough (2006); Lakhani, and von Hippel (2003).

107 See West and Bogers, M. (2013).

fit from intensive external collaboration is linked to firms' capability for identifying, processing and disseminating information generated externally. Market information processing is therefore introduced as a central prerequisite for making collaboration with external sources work.

This study attempts to address this research gap by providing a comprehensive, multi-dimensional approach for successful integrating external collaborators along two dimensions of information processing – information generation and dissemination that are conceptualized in the following section.

2.4. The Role of Information Processing

Having defined what external collaboration in NPD entails for firms in terms of motivation, collaboration type, and possible pitfalls, the next issue becomes how to identify why some external collaborations prove beneficial to NPD projects and others do not?
To examine this more closely, this study employs an information processing approach. Information is a focus in NPD research because it is a critical factor in creating competitive success[108]. Previous research has looked at NPD as an activity that happens at the boundaries between different functions or disciplines[109]. It is in this transfer of information between different approaches and perspectives that the potential for creating something new and market relevant is most present. Sharing information related to a novel product or service is therefore a central capability for successful NPD[110]. However, sharing information across the boundaries requires a great deal of effort[111], be it boundaries between different functional groups within the firm or between the firm and external collaborators. Differences in the level and type of knowledge possessed by different groups, either internal or external, can hinder communication and therefore the flow of

---

108 See Hultink, Talke, Griffin and Veldhuizen (2011).

109 See Carlile (2004).

110 See Cillo, De Luca, and Troilo (2010).

111 See Smits and Kok (2012).

information because a common understanding is harder to achieve[112].

Information processing refers to the interpreting and synthesis of information in the context of organizational design. For information to be understood in the context of the organization, it is important to clarify how it relates to another aspect of the organization's need for input: the relationship between data, information, and knowledge. Data comprise observations, usually statistical in nature. For it to be most valuable, it must be available in the right context and right format and at the right time[113]. The right data found at the right time and in a manageable form can be characterized as information. When it is internalized within the organization, it becomes knowledge[114].

More precisely, information processing is the firm's capability to find the right data at the right time and turn that data into a form that organizational members can use. These tasks become increasingly difficult as the level of uncertainty rises in the environment, within the firm, and within the NPD project[115]. For firms to meet this challenge, they have the capability to collect and process information about their inputs and outputs and about external changes to technology and markets. To accomplish this, firms should be structured in a way that facilities effective, efficient collection and processing of information in and between their departments or business units. Indeed, the information flow in and between subunits should dictate the overall structure.

Previous studies have taken different approaches to analyzing the relationship between information processing and external collaboration in NPD. *Un, Cuervo-Cazurra, Asakawa (2010)* and *Lau, Tang, and Yam (2010)* examined collaboration with different types of external sources from a firm-level capability perspective with a focus on knowledge capture or information sharing. While the insight provided by these authors

---

112 See Leonard (1995); Katz and Tushman (1981); Von Hippel, 1988; Ancona and Caldwell (1992).

113 See Tushman and Nalder (1978).

114 See Carlile, (2004).

115 See Spithoven, Clarysse, and Knockaert (2010).

begins to open the black box of collaboration in NPD, their study does not examine the specific formal and informal firm-level capabilities needed to identify, collect, and disseminate information such that a knowledge transfer can occur between collaborator and innovating firm. Furthermore, given that NPD is a process with inherent uncertainties (market and technological uncertainties, for example), seeing the firms as static entities using NPD capabilities or other resources seems inadequate.

A firm engaged in extensive NPD activities will probably face substantial uncertainty. How much depends on the level of innovativeness involved. NPD teams engaged in projects that may change markets or technology face much greater uncertainty than teams tasked with developing continuous iterations of an existing product line[116]. The former's tasks are more complex given the new ground being broken, and they are likely to depend substantially on capabilities from sources outside the NPD teams. Hence, their information processing requirements will be greater.

The dynamic level of the environment also influences the uncertainty faced by the NPD team. Such teams in relatively stable markets can develop formalized structures and standard operating procedures to deal with their environment. However, in highly dynamic environments formalized structures and procedures can prove a hindrance[117].

Project size also affects information processing requirements. NPD teams working on smaller, incremental projects need little input from other sources inside and outside of the organization. If the need for external and/or internal collaboration is limited, then information processing requirements are low. However, if a project requires coordination with other units such as production, sales, and marketing and multiple external sources are involved, the complexity of the work increases, which in turn boosts the requirements for information processing.

---

116 Smits and Kok (2012).

117 See Leonard-Barton (1993).

The overall insight from the information processing research is that having more information is better, communicating more frequently is better. As CARLILE (2002) pointed out, when uncertainties in the environment arise, so do requirements for information processing. This becomes especially problematic when the new information is of a type or syntax that the current information system cannot handle. Other research has followed this thread further, recognizing that even when common language is present, interpretations of the information introduced are often divergent, which makes communication and collaboration difficult[118]. Studies in the NPD literature note that communication is often difficult because individuals see different meanings in information that relate to their various functional settings[119]. This characteristic has been labeled tacit knowledge or sticky knowledge[120].

2.4.1. Market Information Processing

As discussed in the previous section (2.4.), in terms of the relationship between external collaboration in NPD and NPD portfolio performance, past studies have shown that information processing is a valuable perspective. However, information processing covers a wide variety of activities and much of the literature has focused on information sharing between functional groups or business units. The focus here will instead be on the firm's ability to collect and process market information from its environment.

This approach draws from the marketing discipline but goes further in distinguishing marketing and market information gathering and processing. Responsibility for the former lies with the marketing department. Responsibility for the latter lies with the whole firm[121]. As a further distinction, studies of information processing see the firm as an open system that must deal with uncertainty originating from a changing environment. Research into market information processing sees the vital function of the firm as being

---

118 Redding (1972).

119 Dougherty (1992).

120 See von Hippel and Urban (1988); Nonaka and Takeuchi (1995).

121 Day (1994); Kohli and Jaworski (1990).

its ability to capture and collect information from the market[122].

Success in NPD results in part from firm-level data processing that transforms market information into superior products that respond to customer needs and achieve a competitive edge in the marketplace[123]. Traditional research on this topic has taken a largely local and intra-firm view, focusing on the cross-functional nature of the firm's internal information processing activity[124]. But today the market environment calls for firms to adopt a much broader perspective, one that recognizes the value and importance of acquiring and applying information essential for developing new products for global markets that are widely dispersed functionally, geographically, and culturally[125].

In the narrowest sense, this has been interpreted as the ability to collect and use market information to increase the relevance of product and service offerings and thereby sustain or improve the firm's competitive advantage[126]. Others have included other market actors such as competitors as relevant for information processing activities[127].

Several studies has shown that market information processing in aggregate has a positive impact on firm performance and new product performance[128]. Specifically, the capability to collect and disseminate information enhances a firm's NPD-related activities and performance because it drives a proactive disposition toward meeting customer needs and responding to competitor actions[129]. In addition, market information processing should enhance new product performance because it involves doing something new

---

122 Hult and Ferrell (1997).

123 See Lynn, Reilly, and Akgun (2000); Akgun, Lynn, and Reilly (2002).

124 See Gupta & Wilemon (1990).

125 Barczak & McDonough (2003).

126 e.g., Kohli and jaworksi, 1990.

127 See Cassiman and Veugelers (2006).

128 See Veldhuizen et al. 2011. and Daneels 2003. Bharadwaj, Nevin, Wallman, 2012.

129 See Narver, Slater, and Maclachlan (2004).

or different in response to market conditions[130]. Market-oriented firms emphasize learning about latent customer needs and that learning enhances their ability to create and implement new ideas, products, and processes. This argument suggests that latent customer needs and the urgency of adopting a future market focus within firms' operational routines should be considered in research[131]. Such calls eventually led to researchers making a distinction between responsive and proactive orientations to customer needs. In essence, a responsive market orientation is a business's attempt to tap into customers' expressed needs, whereas a proactive market orientation is the attempt to tap into latent customer needs[132].

2.4.1.1. Information Generation and Dissemination

The firm's marketing function is primarily responsible for acquiring market information. However, others on the NPD team, especially the engineers, technology experts, and controllers, also need to collect this information to create a product that has the right features and price. *Im and Workman (2004)* suggest that market information dissemination has a positive effect on new product performance as it creates a common understanding of market developments across NPD team members from all functions. Additionally, *Gatignon and Xuereb (1997)* proposed that sharing market information is crucial for NPD as it helps the team become aware of potential problems and enhances problem solving. Finally, *Moorman (1995)* empirically found that high levels of knowledge transfer among team members are positively associated with effective, efficient decision-making, and in turn, NPD financial performance. On the other hand, *Henard and Szymanski (2001)* found that excessive collaboration and information sharing can produce a negative performance effect. This has been linked to the concern that firms that pay too close attention to their customers risk losing their innovative edge and instead just respond to the market[133]. This criticism opens up the possibility that the strong

---

130 See Narver and Slater (1990).

131 See Atuahene-Gima et al. (2005); Narver et al. (2004).

132 See Atuahene-Gima et al., 2005; Narver et al., 2004.

133 See Atuahene-Gima, Slater and Olson (2005).

focus on expressed customer needs inherent in a market-based information process limits firms' prowess to develop innovative new products and strategies. This can make it more difficult for firms to bring a product to market that solves an unmet need or existing problems in a new way that appeals to appeals to new and existing customers. A proposed solution to an overemphasis on expressed customer needs is for firms to focus on expressed and latent customer needs. This will help firms be responsive and proactive when engaging in NPD activities[134].

In addition to the firm's need for balancing both latent and expressed needs of the firm should also be mindful that actors have different interests. These interests can become an issue and in situations with a great deal of novelty, because more uncertainty is likely to arise. In an NPD project with a great deal of novelty, the previous knowledge and information held by the actors involved is suddenly at risk of becoming obsolete. A firm with an NPD project aimed at addressing a new customer segment can quickly run into dependency problems when collaborating with existing customers and suppliers because these actors have all their knowledge and information resources embedded in the current products[135]. This makes collaboration challenging since it creates a difference in knowledge between collaborators. In such novel NPD projects previously established mutual practices and knowledge bases are no longer applicable. Hence, conflict of interests arise from the degradation of the knowledge of one actor because of the activities of another, e.g., the firm radically altering its product line potentially degrades the knowledge of its own departments and that of suppliers and customers invested in the current product line. The costs for anyone involved in such a process are therefore not limited to acquiring new information. They also involve transforming current knowledge, processes, and strategies to fit into the new context created by the NPD process. When applying an information processing approach to the analysis of external collaboration in NPD, it is therefore important to not only look at the identification and collection of information but also the dissemination. The latter might be hampered by organi-

134 See Slater, Narver, and Maclachlan (2004); Cillo, De Luca, and Troilo (2010).

135 See Carlile (2004).

zational resistance brought on by the degradation of current resources and competencies that results from the NPD process.

2.4.1.2. Quantitative Research on Market Information Processing

Research on market information processing primarily occurs in the marketing literature, but it has also made inroads into the study of innovation management. The table below lists seven of the articles on market information processing and the relationship between market information and NPD reviewed for this study. All the papers took a quantitative approach in their research similar to the one applied in this study.

Author	Research Question	Theory	Sample	Independent variables	Dependent Variable	Results
Hultink, E. J., Talke, K., Griffin, A., & Veldhuizen, E. (2011).	Does the different market information processing components effect performance.	Information processing.	152 NPD projects.	Acquisition-Dissemination-and use of market information; Information quality; Newness of product.	NPD performance.	Market informations processing does effect NPD performance but the quality of the information greatly affects how the different components impact firm performance.
Maltz, E., & Kohli, A. K. (1996).	Effectiveness of market intellingece dissemination across functional boundaries.	market intelligence.	788 managers from high-tech manufacturing firms.	Information receiver; Interpersonal; Interfunctional; Environmental; Dissemination processes.	Trust Frequency; Formality of intelligence used.	Information obtained through formal channels more valuable than informal obtained info.
Moorman, C. (1995)	information use a result of organizational systems and processes.	Information processing.	92 business units engaged in NPD.	Organizational market information processing; organizational culture.	NPD performance.	Information processing exists in people and therefore is dependent on trust and commitment for effectiveness.
Morgan, N. A., Vorhies, D. W., & Mason, C. H. (2009).	How marketing capabilities are deployed as drivers for firm performance.	Resource-based theory; Information processing.	230 managers.	Market orientation; marketing Capabilities.	Firm performance.	The firms ability to collect market information and utilize its marketing capabilities is a predictor of performance.

Narver, J. C., Slater, S. F., & Maclachlan, D. L. (2004).	Firms differ in their ability to listen to the expressed and latent needs of customers. this impacts NPD success.	Market orientation.	41 business units from 25 firms.	Proactive market orientation; Responsive market orientation; Innovation orientation; Organizational form.	NPD performance.	For sustained NPD success firms must meet both expressed and latent customer needs.
Veldhuizen, E., Hultink, E. J., & Griffin, A. (2006).	The effect of market information processing on new high-tech problems.	New product development ; information processing.	166 manager s from high-tech firms.	Project strategy; Project urgency; firm characteristics; market information processing.	NPD performance; Product advantage.	Market information processing relates differentially to NPD Performance
Zhou, K. Z., Chi Kin Yim, & Tse, D. K. (2005).	Does market orientation impede breakthrough innovations.	Strategic orientation, organization al learning.	239 brands from diverse selection of industries .	Strategic orientation; Market forces; Breakthrough innovation; Organizational learning.	Firm performance; NPD performance.	Market orientation facilitates technological innovation, but has less impact on market innovations.

Table 2. Overview of Research on Market information processing based on large data samples

All seven articles found support for the positive effect of market information processing on NPD performance. However, they all also found that the success of the relationship depends on a wide variety of factors. *Hultnik et al., (2011)* found that market information processing did indeed have significant impact on NPD performance. (This result was somewhat contingent on the quality of the market information collected and disseminated. With quality being defined as information that is collected with an eye on both accuracy and the potential biases) *Zhou, Yim, and Tse (2005)* found similar effects on NPD performance but cautioned that market information collected from customers had more impact on technology-based radical NPD projects than on radical NPD projects aimed at entirely new market segments. Getting quality information from customers can therefore be said to be a problem when the NPD project targets entirely new users rather than targeting existing customers with a new use case.

The challenge of collecting information from external sources in novel NPD projects is further aggregated by organizational internal structures. Different functional groups are

likely to place different values on information gathered from the market depending on their perception of its quality and the manner in which they use it[136]. *Moorman (1995)* found that firms with strong informal structures that stress participation, teamwork, and cohesiveness are better at market information processing. While the concept of market information processing entails using information to guide the firm's direction in general and with regard to its NPD projects, the information processed is usually limited to customer preferences. Moreover, researchers have also focused on how the firm best integrates this information into its own processes. However, what seems not to have been studied is the role of market information processing as a moderating effect on external collaboration in NPD. This study attempts to expand the concept of market information processing as an indicator of the firm's overall ability to identify, collect, and disseminate information from external collaborators based on its awareness of market movements and trends. *As such, it contributes to the existing literature by clarifying how market information processing capabilities affect the effectiveness of external collaboration in NPD.*

2.5. The Contingency Perspective

This literature review began with an overview and analysis of the current literature on external collaboration in NPD and information processing, arguing that a gap in the literature exists concerning the impact of the overall intensity of external collaboration in NPD. Furthermore, a review of the information processing literature points toward the existence of deficiencies in our understanding of the firm-level capabilities the drastically affect the effectiveness of external collaboration in NPD. As the final step in the literature review, it is important to examine studies on external collaboration in NPD done from a contingency perspective, in particular those concerning innovativeness, one of the central contingencies in NPD.

In the context of this study, contingency theory is defined along three dimensions. First, it is assumed that there is a relationship between contingency and organizational struc-

136 Maltz and Kohli (1996).

ture. Hence, a contingency is any variable that moderates the effect of an organizational characteristic on firm performance. Second, contingencies are determinants of the organizational structure because a change in contingencies will require a change in the way organizations organize. Third, for firms to be successful, their structure must fit their contingency. Thus, the higher fit between contingency and structure the higher performance and vice versa[137].

Within contingency theory, firms can be defined as open social systems that must deal with myriad uncertainties with regard to external sources and internal operations. A central task for any firm must therefore be the identification, generation, and dissemination of information to reduce uncertainty throughout the organization, in particular information on how different firm components function and on developments in the external environment. To succeed in this, firms must develop effective information processing capabilities[138]. Indeed, from a contingency theory perspective, the information processing capability of the firm is a key factor in successfully handling the challenges of collaborating externally in NPD. In this study, firms are therefore viewed as information-processing systems. As such, the organizational effectiveness described in the *Tushman and Nadler (1978)* framework becomes a function of how well information processing capacities match up with information processing requirements.

Contingency research in management studies in general and in innovation research in particular is a well-populated field[139]. The research focuses primarily on being aware of two types of contingencies: events or developments brought on by internal firm characteristics and external environmental factors. The essence of the contingency perspective in research is that organizational effectiveness results from fitting the firm characteristics such as structure to the contingencies that reflect the firm's situation[140]. Contingen-

137 See Donaldson (2001).

138 See Bergh (1998).

139 See Donaldson (2001).

140 See Lawrence and Lorsch (1967); Pennings (1992).

cies include but are not limited to environmental factors such as turbulence, firm size, and strategy. Organizations attempt to maintain a fit between their contingencies and structure to maintain high performance.

Contingency theory opposes the tenet that optimal ways exist to organize a firm that many universalistic theories of organization put forward. In this respect, the theory makes two assumptions, both highly relevant in innovation research[141]. First, contingency theory assumes that no superior or inferior approach exists for dealing with management issues. Second, it assumes that specific management approaches or strategies can be equally effective in different environmental or organizational contexts. More specifically, an organization that changes the level of one or more of its contingencies (e.g., decreases its size) tends to have been "in fit" when it made the change. By laying off a portion of its workforce, it becomes "misfit" as its organizational structure no longer suits its size (i.e., the contingency). The organization then has to adapt its structure to its new size to reestablish a high performance level.

Three core elements should be considered in organizational structure. First, there is an association between the contingencies the firm faces (e.g., competitive intensity, technology turbulence, innovation, size) and the firm's structure. Second, contingencies determine the organizational structure and therefore a firm that changes its contingencies must also change how it is structured, e.g., if it downsizes its workforce or changes its technology, organizational changes must follow for the firm to perform. Third, there should be a fit at some level of the organizational structural variable to each level of the contingency. This leads to higher performance, whereas a misfit does the opposite.

So why take a contingency approach when looking at the effectiveness of external collaboration on firm-initiated NPD projects? As noted previously, two of the challenges consistently facing firms are increased market uncertainty and technological turbulence.

---

141 See Calantone, Garcia, and Droge (2003).

The increased use of external collaborators in NPD was identified by *Chesbrough (2003, 2006)* as a response to this pressure, and as a result firm boundaries in many industries have become more porous[142]. From a contingency perspective, the use of external collaborators in NPD can be seen as an organizational change made by firms in response to a series of causal contingencies affecting their performance. The external contingencies of increased market turbulence (e.g., competitive pressure, legislation) and technological turbulence (changes to the firm or industry technological platform) lead to uncertainty about whether the tasks conducted within the organization are appropriate for changing conditions. This is reinforced by the need for innovation.

Contingency theory tells us that firms usually stumble into misfits between their organizational structure and contingencies. When a firm changes its contingencies, it also must change its organizational structure concordantly[143]. Often, misfits decrease organizational performance as the firm struggles to adjust its structure to the new contingency level. While actively pursuing the market rollout of a new product or service, for example, a firm might need to hire additional talent or change location to meet new production needs. Having to cope with this type of uncertainty often increases differentiation in structures within the organization.

In this study, the effect on NPD performance of integrating external sources into the NPD projects is said to be contingent on two characteristics: the firm's information processing capability and the innovativeness level involved in the NPD project. The firm's ability to adapt its information processing capability to the novelty involved in its NPD projects is a critical factor. The more novel the NPD project is in terms of how much it will change the market or the underlying technology, the more information processing capability the firm needs to respond to the greater uncertainty that comes from entering unknown waters. For this reason, in this study the firm's information processing capability serves as an indicator of its ability to benefit from external collaboration in NPD

142 See Chesbrough and Appleyard (2007).

143 See Donaldson (2001).

and the innovativeness level as an indicator of the level of uncertainty involved.

2.5.1. Innovativeness as a Contingency

The final step in this literature review involves introducing the concept of innovativeness. Innovativeness relates to the level of newness or novelty involved in the NPD project. The level of newness also relates directly related to the level of uncertainty involved[144]. The contingency of innovativeness therefore has a direct impact on how the firm must adapt for NPD. Specifically, the firm must maintain the best fit between organizational structure and its contingencies as it encounters market and technology uncertainty. In this dissertation, the term innovativeness takes on a dual role as an indicator of the novelty and uncertainty levels involved in NPD. In other words, in NPD management the level of innovativeness is perceived as a key contingency and the higher the level of innovativeness the more it requires the organization to adapt. With radical innovations it is likely that the firm must adapts its internal processes, adjust its supplier and distribution channels and reconsider both its technology and customer base. Radical innovations are therefore great sources of uncertainty that requires the organization to scramble to stay in fit. Incremental innovations usually only requires minor adjustments in processes and changes to partner relationship or customer base.

Maintaining a high degree of innovativeness within an NPD project can benefit the firm by opening new markets and strengthening its position in existing markets, leaving competitors scrambling to catch up. However, a greater degree of innovativeness in an NPD project creates the higher uncertainties associated with more limited or costly access to information. With a Lack of useful information available at the beginning of a development project, planning may be almost impossible or become too costly. Even if valid information can be generated initially and plans crafted accordingly, highly innovative development may progress along an unexpected path, which requires frequent or continuous information generation and/or updating. In the most extreme case, all resources will be diverted to planning activities, prohibiting efficient, effective product

144 See Melander and Tell (2014).

development. In fact, some in-depth studies of radical innovation management show that teams do not address all uncertainties simultaneously but rather in sequence, reducing one uncertainty before moving on to another[145].

As highly innovative NPD projects often venture into unexplored technological arenas, the probability of unexpected opportunities occurring throughout the development process increases. These unexpected opportunities bump up the importance of conducting regular validity checks. The increased importance of risk planning in cases of high innovativeness is supported by arguments put forward regarding the importance of business planning. As noted, potential risks increase with higher innovativeness. This in turns raises the potential benefits of identifying uncertainties early and implementing contingency plans in a timely manner.

The technology facet of innovativeness relates to changes in components embodied in new products. Technological innovativeness also entails introducing new technological principles that require a new knowledge base[146] while allowing for the realization of significant performance jumps, it often requires fundamental changes in technological system architecture or the use of new components and modules[147]. Highly innovative technologies often force entire industries or the scientific community to alter their knowledge base. In extreme cases, new technologies accompany a paradigm shift in technology or science[148]. They can also, in and of themselves, fundamentally alter the technological trajectory in a particular field such that existing technologies are superseded, e.g., the introduction of combustion engines as opposed to steam based technologies.

Such occurrences illustrate the basic concept of innovations as combinations of new

---

145 See Leifer et al. (2000); McDermott and O'Connor (2002).

146 See Green, Gavin, and Aiman-Smith (1995).

147 See Garcia and Calantone (2002).

148 See Dosi (1982).

means and ends and the concept of innovativeness as a measure of the intensity of change. Higher levels of innovativeness engender changes, often multiple ones, to technological and resource-related means and market-related ends. Firms must provide, for example, at least some increase in customer benefits to create a relative product advantage that helps drive new product adoption[149]. This requirement will changes the market dimension for each product innovation in general and the incremental instances in particular.

Alterations to the technology dimension will also likely occur as a result of product innovations, particularly within technology-oriented firms where technological developments are essential to business[150]. In all cases, firms that face the steady emergence of new technologies and the accelerating development of existing technologies need to revise and update the technological base for almost every new product[151].

In contrast, the firm's internal and external resources will only be altered if the product newness increases radically. Incremental innovations exploit existing resource bases and subsequently build on existing knowledge as current products and services are updated[152]. Only highly innovative activities involve exploration, substantial higher order learning, experimentation, and risk-taking[153].

2.5.1.1. Quantitative Research on Market Innovativeness

While all the potential facets of innovativeness can affect NPD portfolio performance, this study will focus on market innovativeness. Eight of the studies on innovativeness used in this dissertation (listed in the table below) find market innovativeness to be one of the most challenging contingencies for NPD processes with external collaborator en-

149 See Rogers (2010).

150 See Gemünden et al. (1992).

151 See Sood and Tellis (2005).

152 See Bierly and Daly (2007); March (1991); Nerkar (2003).

153 See Benner and Tushman, 2003; Cheng and Van de Ven, 1996.

gagement due to the limited ability of external actors to conceptualize profound changes in features or target markets.

Author	Research Question	Theory	Sample	Independent variables	Dependent Variable	Results
Jordan, G., & Segelod, E. (2006).	How product innovativeness impacts NPD outcomes,	NPD management	94 projects	Innovativeness	Firm Performance; Knowledge enhancements; link to external actors.	The high innovative products show higher project performance, knowledge enhancement outcomes and external sources of knowledge used by the firms during the knowledge acquisition process, also show some positive outcomes
Ali, A., Krapfel, R., & Labahn, D. (1995).	How product innovativeness and entry strategy impacts the time it takes to bring a product to market.	NPD management	129 firms	Entry strategy; Product innovativeness.	Time to break-even; Cycle time	Short product development equals faster break-even. NPD times kept low by keeping technical complexity low.
Atuahene-Gima, K. (1995).	Examines the impact of market orientation on NPD performance.	Market orientation; NPD management.	275 firms	market orientation; NPD activities; Innovativeness; Environmental hostility; Product life cycle.	NPD performance	The impact of market orientation greater in: incremental products, and in early stage of products and in hostile competitive environments.
Green, S. G., Gavin, M. B., & Aiman-Smith, L. (1995).	Examines the concepts of incremental and radical innovations.	NPD management	21 firms	Uncertainty; Technological cost; Technological and business inexperience; Termination	Project impact on firm; Project life-span; Project Origin.	The utility of these measures and dimensions as diagnostic tools in project management is discussed.

Kleinschmidt, E., & Cooper, R. (1991).	Examines the relationship between innovativeness and NPD performance.	NPD management	125 firms	Innovativeness measures.	NPD success measures	Finds that the relationship is u-shaped. Indicating that both radical and incremental innovations are profitable but that some fall in between.
Molina-Castillo, F. J., & Munuera-Aleman, J. L. (2009).	Examines the relationship between quality, Innovativeness and NPD Performance.	NPD management	110 firms	Technology fit; marketing fit; Innovativeness; Product superiority; Compatibility; Complexity; Quality.	Financial, market, and customer performance.	Innovativeness negatively impact short term performance, but in interaction with quality it positively impact performance.
Song, X. M., & Montoya-Weiss, M. M. (1998).	Examines if the development of radical new products requires a different approach than incremental NPD.	NPD management	332 NPD projects	incremental and radical innovativeness; Strategic planning; Idea development; Opportunity analysis; Technical development; Product testing; Commercialization.	NPD Success	Business and market opportunity analysis improvements are counterproductive for radical new products but increase profitability for incremental NPD.
Souder, W. E., & Song, X. M. (1997).	Examines product design and market choice drives NPD success.	NPD management	50 firms	Design parameters; market parameters; market uncertainty.	NPD Success	Radical new products are detrimental to performance in situations with low market uncertainty. Even under high uncertainty success is not guaranteed.

Table 3. Overview of Research on Market innovativeness in NPD based on large data samples.

The market facet of innovativeness relates to the changes new products cause within the market. A central criterion of market innovativeness is whether the innovation will change customer value significantly compared to prior products. This can be accomplished by fulfilling previously unsatisfied needs and/or creating new customer benefits that may change market structures and address a new customer base. In extreme cases, a new product is the first of its type and establishes a new product category or creates a

completely new market.

NPD aimed at creating new markets or product categories can be a messy affair, and the quantitative studies on market innovativeness reviewed for this study highlight the risk-reward that seems to be present when innovating along the incremental to radical continuum. *Kleinschmidt and Cooper (1991)* examined whether incremental or radical NPD projects increase performance. They found that product innovativeness did have a strong impact on performance for radical new products[154]. However, this result also applied in almost the same degree to incremental new products at the opposite end of the continuum. Interestingly enough, these findings indicate a U-shaped relationship between product innovativeness and performance, that is, the only detrimental NPD strategy seems to be aiming at the middle of the incremental-radical continuum where the primary challenges to incremental and radical NPD are both present. In that part of the range, it is difficult to capture the benefits of really new products that open up new markets or product categories, as with radical NPD. At the same time, it is harder to reap the benefits gained from the synergies and established marketing that characterize the spectrum's incremental end.

Other studies have expanded these results, finding for example that capturing the benefits on the U-shaped curve of market innovativeness depends greatly on characteristics such as firm size[155], time to break even[156], and the greater risk associated with introducing radically new products[157]. For really new products, customer needs are often hard to pin down and competitor capabilities not clearly established. As a result, much of the market information processing that firms normally engage in during NPD is of little use and can be exorbitantly more costly than the value of the intelligence provided. Indeed, investments in customer "re-education" and market intelligence have a negative impact

---

154 See Jordan and Segelod (2006).

155 Souder and Song (1997).

156 See Krapfel and Labahn (1995).

157 Green, Gavin, and Aiman-Smith (1995).

on performance for radically new products[158]. These effects are likely to be exacerbated by the customers' ambivalent feelings toward new products[159]. *Lee and O'Connor (2003)* found the customers faced with an innovative new product often experienced positive perceptions such as surprise and optimism as well as negative perceptions related to discomfort and insecurity, making radical NPD a challenging balancing act.

The difficulties associated with radical NPD also translate directly to the firm's ability to use market information processing in its NPD processes. *Atuahene-Gima (1995)* found that market information had the greatest effect on incremental innovations, e.g., when the level of innovativeness was low for the customer and the firm. The effect was also measurable for NPD projects with higher levels of innovativeness but not to the same extent. *Atuahene-Gima (1995)* also found that using market information created benefits for individual project and across many firm activities. These studies indicate that, while the benefits of information processing are harder to capture in radical NPD projects, information processing can still mitigate some of the risk inherent in the NPD process, especially for projects with a high degree of innovativeness. For this reason, researchers have deemed it beneficial for firms engaged in very innovative projects to establish links to external information sources and to include the maintenance of such links in their NPD budget[160].

2.6. Implications From the Literature Review

Among other things, this literature review provided a theoretical framework for introducing the main independent variables that apply to NPD—external collaboration, information processing, and innovativeness—and to relate them to performance, the NPD dependent variable. The literature review also revealed a certain level of ambiguity regarding the concept of external collaboration in NPD. The performance effect of certain aspects of external collaboration has been extensively documented. Certain other as-

158 Song and Montoya-Weiss (1998).

159 Molina-Castillo and Munuera-Aleman (2009).

160 Jordan and Segelod (2006).

pects of the concept are less clear—for example, the issue of who to collaborate with under what circumstances and the challenges involved in effectively transferring collaborator knowledge and information assets to the firm conducting the NPD project.

While the overall research into integrating information and ideas from external sources in the NPD process appears to be maturing, the literature review demonstrated that the effect of many external collaboration dimensions on NPD portfolio performance is still being debated and that our understanding of the complexities involved in integrating external sources of information is limited. Furthermore, few studies take a broader approach to look at how firms perform when the whole range of external collaborators are taken into account simultaneously. *Laursen and Salter (2006)* is the most notable exception to this observation. Their study suggests that the enthusiasm for openness needs to be tempered by an understanding of the costs of such search efforts. Furthermore, external sources need to be managed carefully so that search efforts are not spread across too many search channels. Likewise, *Un, Cuervo-Cazurra and Asakawa (2010)* contributed to our understanding with findings that indicate that ease of knowledge access, rather than breadth of knowledge, appears to drive the success of R&D collaborations for product innovation. They also found that R&D collaborations with suppliers or universities, which are characterized by relatively easy access to knowledge, have a positive influence on product innovation, whereas R&D collaborations with customers or competitors, where access to knowledge becomes more difficult, are neutrally or even negatively related to product innovation. Moreover, to achieve product innovation with the help of external collaborations, it appears the collaboration must first have mechanisms in place to facilitate information transfer. Once these are in place, the collaboration works better if the external partner has a relatively narrow knowledge base. These findings indicate that external collaboration overall should have a positive impact on NPD performance.

Previous research points toward an explanation for this. *Leonard-Barton (1995)* suggested that innovative products happen at the boundary between different functions or

disciplines. The diversified input from the different functions help the firm spot new opportunities for the product, process, and/or service. In light of this, a strong capability for information processing is an essential skill to have when trying to collect and disseminate relevant information during the NPD process[161]. The same capability has also been shown to be one of the main drivers of success when trying to orient the firm toward meeting direct and latent market demands[162]. Information processing can therefore be said to be a central capability for NPD, whether it be internally driven or conceptualized from other market actors, and the firm's primary function in this regard is to act as an information processing system that winnows out the internal and external data most relevant to and most useful for the NPD project at hand.

Market innovativeness from a contingency perspective is a powerful dynamic within the NPD process. Both as a potential benefit, but also a source of uncertainty. However, the literature on external collaboration is unclear as to the effect of market innovativeness when external sources are involved in the process. Are products that are radical new to the market better off being developed primarily as an internal project or do the increased requirements for relevant information in radical new products benefit from many external sources? Contingency theory predicates that a contingency such as market innovativeness requires a shift in the firm structure for optimal performance, but the implications for external collaboration in NPD remains unclear. While external sources are not traditionally viewed as part of the firms structure, their position becomes somewhat less clear when they are intensively used to develop new products. From the literature, it certainly appears as if their role should not be underestimated[163]. Hence, a change in the level of market innovativeness is also likely to require a change in the way firms engages with their external sources. In other words, further examination is needed to assess whether the intensity of external collaboration should increase when the level of

---

161 e.g., Tushman and Nadler (1978).

162 e.g. Veldhuizen et al. (2011).

163 e.g. Petersen, K. J., Handfield, R. B., & Ragatz, G. L. (2003); Jeppesen, L. B., & Frederiksen, L. (2006).

innovativeness goes up, or if it should decrease.

Chapter 3 - Hypotheses Development

Chapter 3 introduces this study's conceptual framework and research hypotheses. First, implications from the literature review as they relate to the research questions are discussed. Second, success hypotheses are derived for external collaboration and the two information processing dimensions used in the study: information generation and information dissemination. Third, moderation effects for the combined effect of the external collaboration and information-processing dimensions are introduced. This is followed by a discussion the moderating effect of innovativeness on the external collaboration and NPD portfolio performance relationship and the information processing dimension's effect on NPD portfolio performance. Finally, three-way interactions are introduced to test the combined effect of external collaboration in NPD projects on NPD portfolio performance when moderating with innovativeness and either of the information processing dimensions.

In brief, this chapter will explicate

- the hypothesized positive relationship between the independent variables and the intensity of external collaboration and the information processing constructs of information generation and dissemination with regard to the dependent variable of NPD portfolio performance;
- how the interaction between the intensity of external collaboration and the market information constructs increases the positive impact on NPD portfolio performance; and
- the impact of market innovativeness on the relationship between the intensity of external collaboration and market information processing on NPD portfolio performance.
-

The chapter concludes with an overview of all hypotheses tested in the empirical study.

3.1. The Conceptual Model

Based on the literature review presented in Chapter 2, relationships between external collaboration and NPD portfolio performance and between information processing and NPD portfolio performance are assumed. External collaboration is conceptualized as a multifaceted scale encapsulating the different types of possible collaborators and the extent to which the firm collaborates with them. Information processing is conceptualized along two dimensions: the firm's ability to identify and collect information from external collaborators and the firm's ability to disseminate this information throughout the organization via formal and informal means. Furthermore, it is expected that the level of innovativeness influences these performance relationships depending on the fit between the use of external collaborators and the information processing capabilities.

The conceptual framework of this study, shown in Figure 2, has been conceptualized based on the assumptions described above, which will be elaborated on and supported below. In addition to those relationships, six control variables have been included in the model for completion and to test for rival hypotheses: geographical location, firm size, level of decision-making formalization, customer focus, level of turbulence in the environment, and level of technological innovativeness.

The conceptual framework serves as a measurement model for the empirical analysis. In addition it is used to structure the sections that follow. First, the external collaboration hypothesis is derived, followed by three success hypotheses related to the information processing dimensions. Next, the moderating effect of innovativeness is added, and, finally, the three-way interaction effects are introduced.

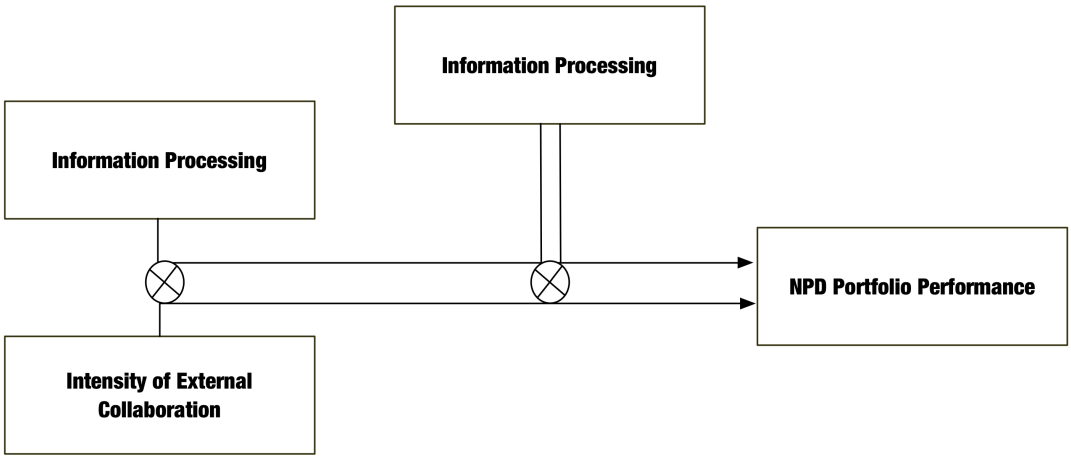


Figure 3. The basic conceptual model.

3.1.1. External Collaboration and NPD Performance

The previous chapter established that to attain and keep a sustainable competitive advantage firms must develop more innovative products. However, focusing NPD on creating products that offer something significantly different to existing customers or targets entirely new customers beyond the firm's product portfolio is challenging. For the majority of firms, their knowledge base is to a large extent defined by their current operations, which do not necessarily provide the information needed for more radical NPD[164]. This makes the need for relevant and timely knowledge about market and technology developments more pressing[165]. To expand the amount and quality of their knowledge, firms are turning to external collaborators for new input into the NPD process[166]. External collaboration gives firms the potential to reduce the cost of innovation and NPD by shortening time to market[167]. It also improves the potential quality and quantity of innovation through the external knowledge it provides. Working closely with external resources also enhances the firm's ability to track changing market demands

164 See Piller and West (2014); von Hippel (1986); West and Bogers (2013).

165 See Chesbrough (2003); Dahlander & Gann (2010).

166 See Ahuja (2000); Brettel & Cleven (2011).

167 See Chesbrough and Crowther (2006).

and identify potential opportunities for spillover effects[168]. External collaborators therefore become complementary assets that, in conjunction with the firm's own NPD assets, can turn an innovation into a commercial success[169]. The move toward collaboration outside the firm is being driven by competitive intensity. It is also being motivated by the attractiveness of the increased information access made possible by the widespread diffusion of information and communication technologies that makes it easier to take advantage of external competencies.

The competencies relevant for NPD can be found all along the value chain—from supplier to end customers. In a study of intensive Italian design industries, *Dell'Era and Verganti (2010)* observed that, while the contributions of external collaborators might not be individually identifiable, when merged with other external inputs and internal R&D capabilities they can create a mass of knowledge for use in the NPD process over time. In line with this, this study examines the breadth and depth of all external collaborator contributions in so-called 'inbound open innovation" activities. In this regard, the breadth refers to the number of external sources—customer[170], suppliers[171], competitors[172], or research institutions[173]—that collaborate with the firm and the depth refers to how closely the firm collaborates with these external sources[174].

Hypothesis 1. A positive direct relationship exists between the intensity (breadth and depth) of the firm's external collaboration and NPD portfolio performance.

---

168 See Chesbrough & Appleyard (2007); van de Vrande, de Jong, Vanhaverbeke, and de Rochemont (2009).

169 See Hagedoorn (1993); Rothaermel and Hess (2007); Teece (1986).

170 See Bartl, Füller, Mühlbacher, and Ernst, (2012); Cooke & Schienstock (2000); Jeppesen & Frederiksen (2006); Urban & von Hippel (1988).

171 See Bonaccorsi & Lipparini (1994); Clark (1989); Petersen et al., (2005); Ragatz, Handfield, & Petersen (2002); Song & Di Benedetto (2008).

172 See Gnyawali and Park, 2011; Ritala and Hurmelinna-Laukkanen, 2013.

173 See Bruneel, D'Este, and Salter, 2010; Laursen & Salter, 2004.

174 See Laursen & Salter, 2006.

Figure 4. intensity of external collaboration & NPD portfolio performance.

3.1.2. Market Information Processing and NPD Performance

A major challenge for firms engaging in external collaboration for NPD is how to identify potential collaborators and how to extract and internalize the information generated from the collaboration effectively. A market information processing analysis approach is therefore useful in highlighting some of the inter-firm capabilities needed for find, collect, and disseminate information from the market. *Slater, Narver and Machlachlan (2004)* found that for firms to avoid the pitfall of simply responding to the market by solely monitoring and collecting data, they need to engage with and lead customers. Their research also found that for this to be effective firms must facilitate the free flow of knowledge rarely found in large highly formalized organizations[175]. This has two important implications for the rest of this study. First, as *Slater, Narver and Machlachlan (2004)* noted, a strong positive relationship between a firm's ability to engage with customers and other market actors and new product performance. From this study's perspective, this relationship is just as important when the firm is actively engaging with external sources in NPD beyond customers. The value firms can capture from external sources therefore directly relates to their information processing capability. Second, the level of innovativeness, and thereby uncertainty, has a tremendous impact on this relationship as it makes it harder for the firm to identify, collect, and disseminate information from external sources. Third, the more innovative the NPD project is, the more

175 See Donaldson (2001).

likely it is to degrade knowledge bases, strategies, and processes already established within the company and in connection with external collaborators. A high degree of innovativeness also makes it more challenging to identify, collect (or generate), and disseminate information.

To date, it appears that little attention has been given to the internal capabilities needed to integrate external sources of innovation, with the notable exceptions of *Herzog and Leker (2010)* work on the impact of firm culture and *Cassiman and Veugelers (2006)* paper on the effects of firm strategy. To establish a more complete picture of the competencies needed to make effective use of external collaboration, the research here draws on information processing theory and in particular market information processing theory. At its core, information processing theory views the organization as an information processing system that faces uncertainty[176]. From a market perspective, information processing theory views the firm's ability to collect and absorb information from the market as a central indicator of its capability for reducing external uncertainty.

The market information processing theory has already been applied in the NPD setting. The previous research found that information processing is positively linked to performance and NPD success[177]. According to *Day (1994)*, effective learning about markets is a continuous process that pervades all decision-making activities. Continuous market learning helps managers repeatedly anticipate market opportunities and respond ahead of their competitors and create a competitive advantage. This observation brings to mind the call by *West and Borges (2013)* for evidence and a supporting theory for the competencies required for successfully integrating externally sourced innovation. Indeed, the combined approach of external collaboration and market information processing is what can turn external sources of innovation into value-adding elements.

---

176 See Tushman & Nadler (1978); Wu (2010).

177 See Atuahene-Gima & Ko, 2001; R. Calantone, Cavusgil, & Zhao, 2002; E. Kleinschmidt, De Brentani, & Salomo, 2010.

While the breadth and depth definition of external collaboration proposed by *Laursen and Salter (2006)* covers the number of collaborations and their intensity, it fails to grasp the competencies needed to execute collaborative activities successfully. To address the challenges of incorporating externally sourced input into the NPD process, this study adopts two perspectives from the market information processing research: market information generation and market information dissemination[178].

The measure of market information generation covers the firm's ability to identify collaborators and extract information from them for use in the NPD process. Research by *Griffin & Hauser (1993)* showed that when NPD team members generate information from the market, it enhances the individuals understanding of the challenges associated with the product. Often NPD team members will even assign higher value to information collected from customers, which can facilitate conflict resolution and provide clarity in the NPD process[179]. Previous research by *Li and Calantone (1998)* showed that being able to identify and integrate information from other market actors was advantageous to NPD.

Hypothesis 2a. A positive direct relationship exists between the intensity of the firm's market information generation and its NPD portfolio performance.

178 See Hultink, Talke, Griffin, and Veldhuizen (2011); Kohli, Jaworski, and Kumar (1993); Sinkula (1994).

179 See McQuarrie (2008).

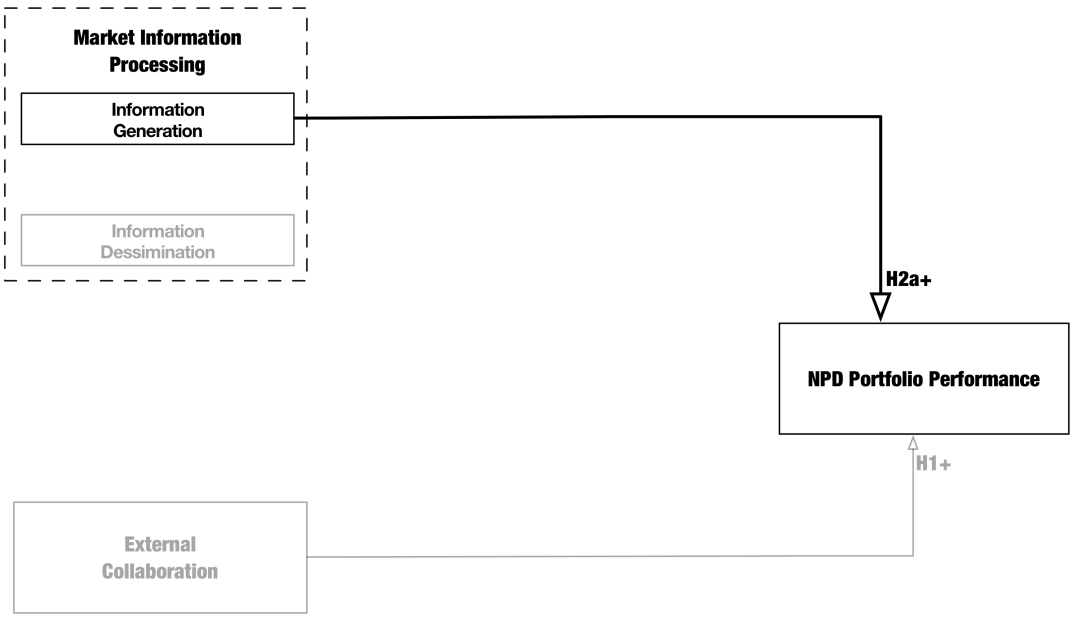


Figure 5. Market information generation and NPD portfolio performance.

The second perspective from market information processing theory—information dissemination—relates to the organizational structures in place for dispersing information internally. Information dissemination is therefore important for planning and managing NPD[180]. However, most of the new product literature does not refer to information dissemination explicitly or test this factor empirically.

Nevertheless, previous research has shown that the ability to disseminate market information assists the firm in spreading relevant information throughout the organization[181]. Information dissemination creates a shared understanding of market demands, technological developments, and competitor actions within the organization across all functions and hierarchical levels[182]. A high level of information dissemination leads to a quick response to external or internal surprises. Moreover, it compensates for a coordination mechanism instead of planning and facilitates learning from previous experi-

180 See Kohli and Jaworski (1990); Veldhuizen et al., (2006).

181 See Bergh (1998).

182 See Im and Workman (2004).

ences.

A higher level of information dissemination will therefore have a positive impact on the quality trade-off decisions in strategic planning, especially in dynamic environments. Effective information sharing across organizational boundaries and between team members increases the efficiency of the decision-making process and so affects NPD performance[183]. It also enables the firm to better react to complications in the NPD process and increases problem-solving capabilities, an ability that has also been viewed as a key component in NPD performance[184].

Hypothesis 2b. A positive direct relationship exists between the intensity of the firm's market information dissemination and its NPD portfolio performance.

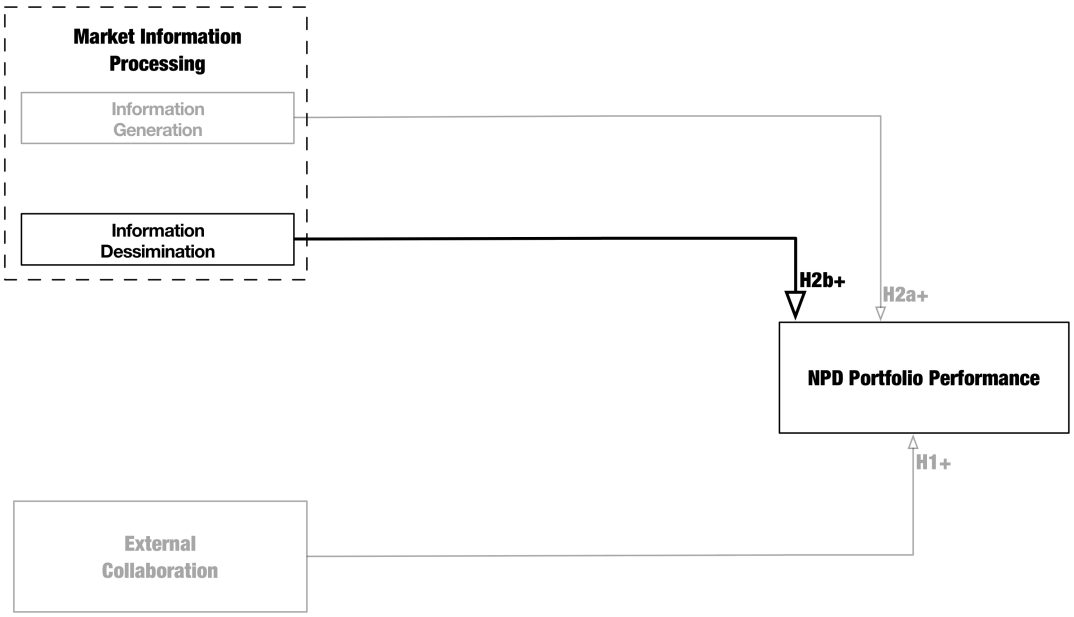


Figure 6. Market information dessimination on NPD portfolio performance.

When considering a potential interdependency between market information generation and dissemination, previous literature shows that disseminating information gained

183 See Henard and Szymanski (2001).

184 See Gatignon and Xuereb (1997).

from the market has a positive impact on NPD[185]. Understanding market conditions and prioritizing NPD tasks is of vital importance[186]. Moreover, since NPD in most firms is a cross-functional operation, creating cohesion among different functional groups becomes a central task in NPD. The capability to identify, generate, and disseminate market information throughout the organization helps the different functional groups validate or dispel different assumptions concerning market conditions and task relevance[187]. This validation of assumptions also reduces conflicts that might arise from differing opinions. As a result, the different functional groups involved in NPD are better equipped to coordinate resources in the NPD process, which allows for faster and more efficient NPD[188].

In addition, market information processing helps the firm sense new opportunities among its customer base as well as threats from external sources such as competitors, legislation, and new technology[189]. It can provide the firm with the capability to identify partners and absorb their knowledge into the NPD process. This also leads to more cohesion within the NPD team and increased NPD performance. It is therefore likely that NPD performance is particularly strong when generation and dissemination of market information go hand in hand.

Hypothesis 2c. Combining market information generation and dissemination further enhances NPD portfolio performance.

---

185 See Han, Kim, and Srivastava (1998); Hunt and Morgan (1995); Narver et al. (2004); Ottum and Moore (1997); Veldhuizen et al., 2006.

186 See Daniel Sherman, Berkowitz, & Souder, 2005; McDonough, 2000; Rajesh, Smith, & Park, 2001.

187 See Cummings (2004); Milliken and Martins (1996).

188 See Gatignon and Xuereb (1997); Hultink et al. (2011).

189 See Teece (2010).

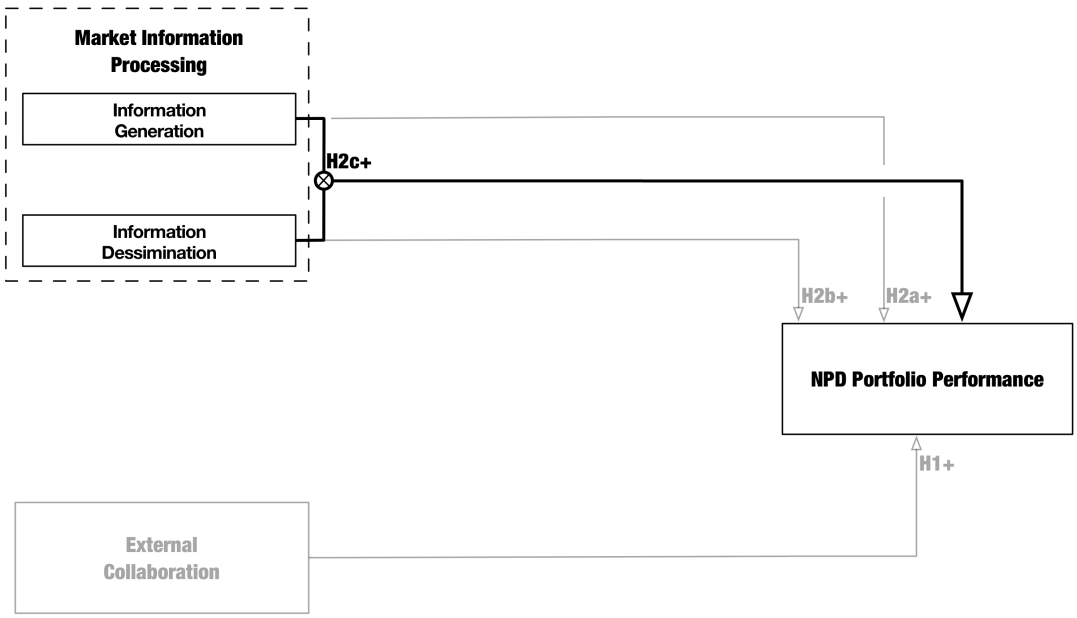


Figure 7. Market Information processing and NPD portfolio performance.

Hypotheses 1 and 2 indicate that external collaboration and market information processing contribute to NPD performance within the firm. It also seems likely that collaboration and information processing, when executed conjointly, enhance NPD performance. Indeed, the presence of market information processing capabilities might be a prerequisite for successfully identifying collaborators valuable to NPD and generating information from them for dissemination throughout the organization.

The reason for expecting this interaction is that the inbound open innovation and market information processing theories both highlight the importance of interaction between the information embedded in external sources and the firm's ability to use it[190]. The notion that effective external collaboration is related to the firm's capability to identify collaborators and acquire information from them is a new concept. It is true that previous research into the internal structures needed to leverage external sources in NPD found that organizational practices affect the firm's ability to benefit from external col-

190 See Tushman, Lakhani, and Lifshitz-Assaf (2012).

laboration[191]. However, so far the literature has not covered the information processing capabilities needed to make effective use of external collaborators, choosing instead to focus on task autonomy and incentive systems among other topics[192]. Still, a core competency for using external sources of innovation effectively would seem to be the firm's ability to identify and acquire information. A central challenge with this task when dealing with external sources of innovation is identifying the right collaborators—for example, determining which users are the lead users[193] or which supplier or manufacturer has the relevant strategic and technological platforms needed to make them a suitable collaborator[194].

After identifying the right collaborator, the next challenge is acquiring useful information from them. Getting information relevant for the innovating firm from these sources can be difficult. Previous research has labeled this such information as "sticky" because it is difficult to share outside the context in which it was generated[195]. The innovating firm's capability for market information generation is therefore central for the successful integration of external sources of innovation in the NPD process because it enables the firm to identify and capture information from collaborators.

Hypothesis 3a. Combining the intensity of collaboration and market information generation further increases NPD portfolio performance.

---

191 See H. W. Chesbrough, 2003; Fey & Birkinshaw, 2005; Gassmann, 2006; Laursen & Salter, 2006.

192 See Foss, Laursen, and Pedersen (2011).

193 See Füller, Matzler, Hutter, & Hautz, 2012; Hoyer, Chandy, Dorotic, Krafft, & Singh, 2010; Jeppesen & Molin, 2003.

194 See Melander and Tell (2014); Petersen et al., (2005).

195 See Von Hippel (1994); Ogawa (1998); Piller and Walcher (2006).

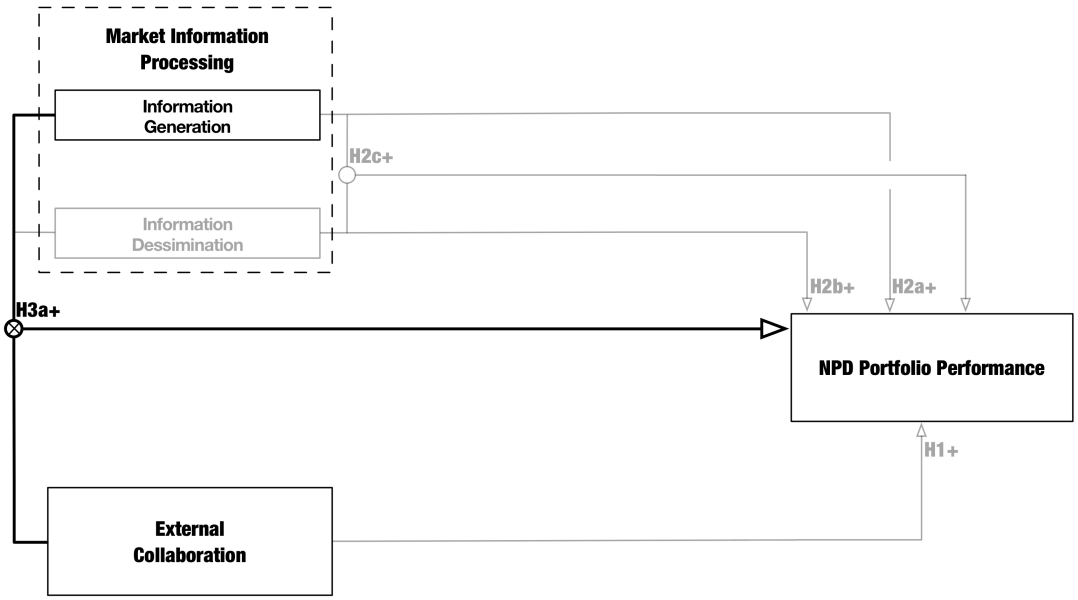


Figure 8. Intensity of external collaboration and Market information generation Interaction on NPD portfolio performance.

Having strong capabilities for market information processing increases the firm's ability to disseminate relevant market information throughout the organization. This allows for close collaboration with external sources, which might help mitigate conflicts within the firm by corroborating or refuting assumptions in the decision-making process. In addition, the spread of information across and beyond the NPD team is likely to bring up additional ideas and questions, which in turn require more answers from collaborators and results in deeper collaboration. The ability to benefit from external collaboration in this way seems directly related to the firm's capability for market information dissemination.

Hypothesis 3b. Combining the intensity of collaboration and market information dissemination further increases NPD portfolio performance.

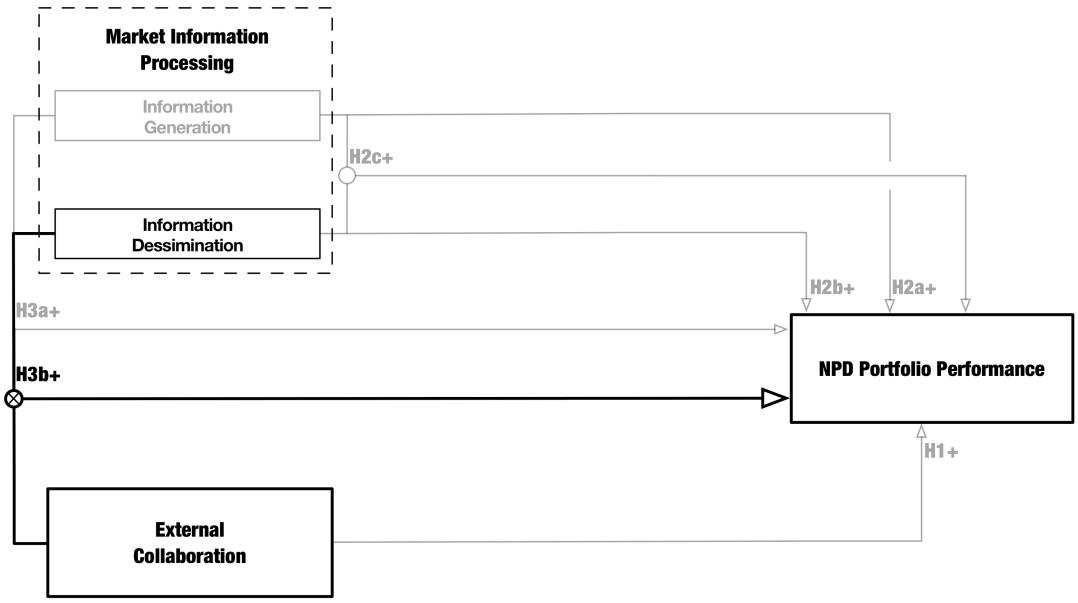


Figure 9. Intensity of external collaboration and Market information dessimination interaction on NPD portfolio performance.

3.1.3. The Moderating Effect of Innovativeness

The firm's ability to sustain a long-term competitive advantage has been directly linked to its ability to launch new products and services to the market[196]. Previous research on innovativeness offers a wide variety of definitions of and perspectives on this concept[197]. In general, though, the degree of change associated with a new product is generally a good indicator for innovativeness. In terms of market innovativeness, this is generally associated with features new to current customers. If the new product is highly innovative it might even address customer segments that was previously not touched by the innovating firm. In either case, the use of new features may have to be learned and compatibility with other products explored. This greatly increases uncertainty, especially for customers already familiar with the current product offerings[198].

196 See Ahuja, 2000.

197 See Garcia & Calantone, 2002.

198 See Calantone, Chan, and Cui (2006); Chatterjee and Eliashberg (1990).

Within the field of NPD, it is recognized that developing new products with high degrees of newness differs markedly from incremental NPD[199]. As discussed in the literature review, increasing degrees of market innovativeness correlate with greater market-related uncertainties. The risks associated with such uncertainties, along with the higher costs involved in this type of NPD, are the main drawbacks of pursuing a higher level of innovativeness. The more radical an innovation is, the riskier it tends to be. *Leifer et al., (2002)* distinguish between four types of risks: technical, market, organizational, and resource-related. Managing and mitigating these risks requires time and money.
Furthermore, the success rate of radical innovation projects is lower due to the higher uncertainties. A low success rate can reduce or eliminate returns from innovation and this can affect firm performance.

Radical innovation projects also require a different, more demanding type of management to succeed. This implies a need for greater firm resources, which also can have a negative influence on performance.

Hauschildt and Salomo, (2011) argue that the risks and costs associated with more radical innovations increase disproportionately to returns. They believe the relation between innovativeness and profitability is an inverted-U shaped. As noted, the greater the degree of innovativeness involved in an NPD process, the greater the uncertainty associated with the project. The uncertainty associated with a high degree of innovativeness is by definition accompanied by limited or costly access to relevant information[200]. Integrating an external collaborator into the NPD process has been viewed by previous literature as a way to gain access to product relevant information that might otherwise be hard to acquire[201]. However, increasing the number of collaborators or the intensity of collaboration poses a problem because it also increases the requirements for identifying, acquiring, and disseminating the information within the recipient organization, some-

199 See Su, Ahlstrom, Li, and Cheng (2013).

200 See Rogers, 2003.

201 See Urban and von Hippel (1988).

thing that is already challenging in NPD projects with a high degree of innovativeness.

Hypothesis 4a. The firm's ability to benefit from external collaboration in the NPD process is weakened when the new product development program has a higher degree of market innovativeness.

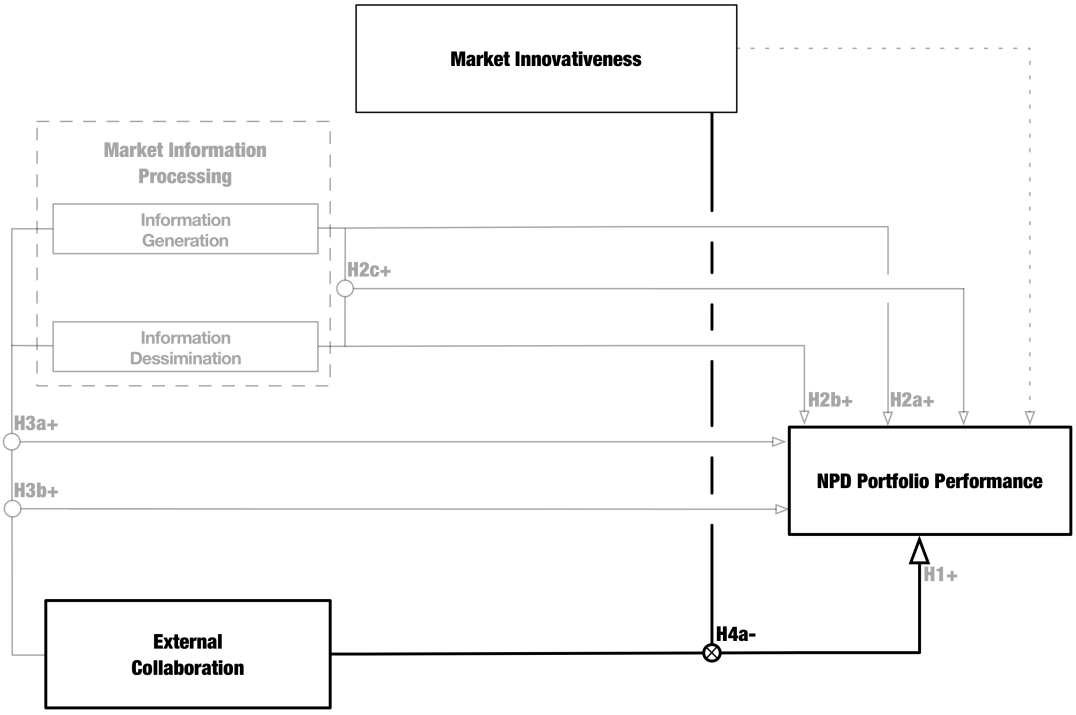


Figure 10. Intensity of external collaboration and Market innovativeness Interaction on NPD portfolio performance.

Including external collaborators in radical NPD projects is therefore something of a two-edge sword. The collaborators might provide the organization with information that complements the NPD process. However, and perhaps more importantly, the resources needed to identify external collaborators and acquire knowledge from them might be resource-intensive to an extent that outweighs the benefits of collaboration. Highly innovative projects might frequently evolve in unexpected directions and require knowhow and information previously unrelated to the project[202]. In these cases, the amount of resources needed to identify and generate information from external collabo-

202 See McDermott and O'Connor (2002).

rators might be unsustainable, thus prohibiting efficient and effective NPD[203]. In addition, if the level of innovativeness is high, the firm might have trouble just identifying collaborators with relevant knowledge, making the search for external sources of innovation an even greater resource sink. Based on this, it seems likely that external sources of knowledge and information contribute positively to the NPD process more easily when uncertainly levels are relatively low and the frame of the NPD project is more fixed, as with incremental innovations.

Hypothesis 4b. The firm's ability to benefit from market information generation in the NPD process is weakened when the new product development program has a higher degree of market innovativeness.

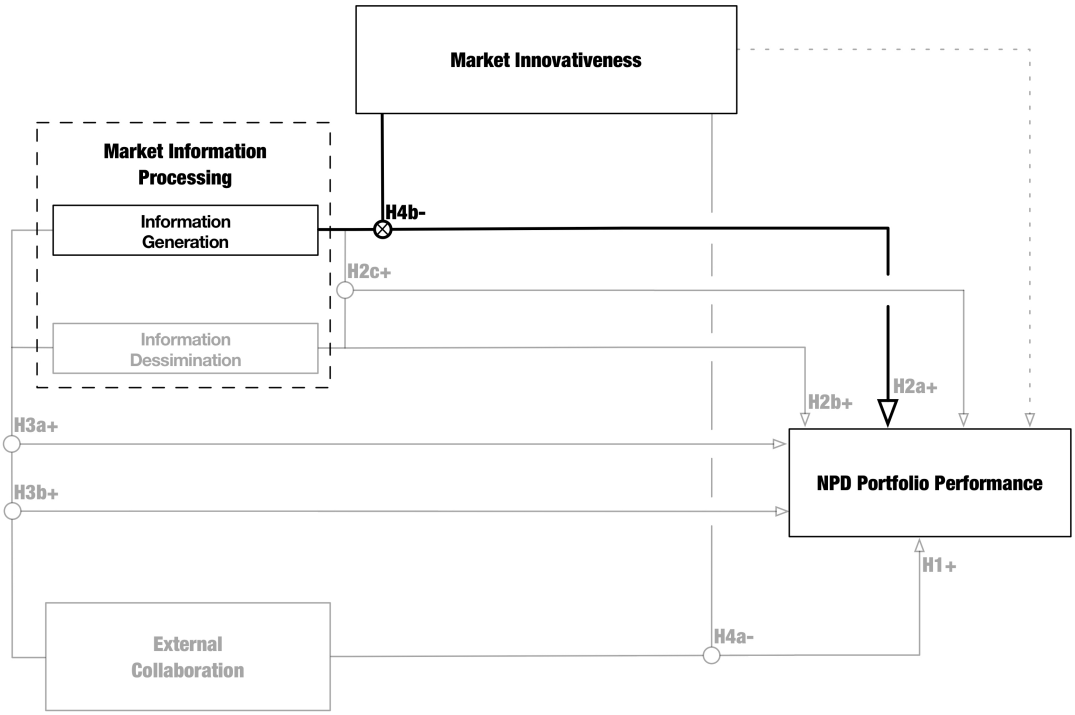


Figure 11. Market information generation and Market Innovativeness Interaction on NPD portfolio performance.

Highly innovative NPD projects also pose a problem in relation to the dissemination of information throughout the organization. Specifically, when individual members of the

203 See Faems, de Visser, Andries, and Looy (2010).

NPD team succeed in identifying and generating relevant information for the NPD process, disseminating it across the organization effectively faces two major obstacles. The first relates to the tangible and intangible structures for facilitating information flow within the organization. The information might be of a type or quantity that the dissemination system is not suitable to process. For example, managers may be used to financial or statistical market data being presented with information from key product users or component suppliers and therefore not giving the external information enough credence.

The second problem relates to organizational opposition to new input. This can make members of the organization reluctant to receive information and/or support ideas that might degrade or cannibalize products within their sphere of influence[204]. Other research has labeled such differences in interests as "creative abrasions."[205] Organizational members resisting innovation will likely try to invalidate the external input, creating bottlenecks that hinder the spread of information and erecting barriers within the organization to limit the success of radically new initiatives.

Hypothesis 4c. The firm's ability to benefit from market information dissemination in NPD is weakened when the new product development program has a higher degree of market innovativeness.

204 See Tidd and Bessant (2009).

205 See Leonard-Barton (1995).

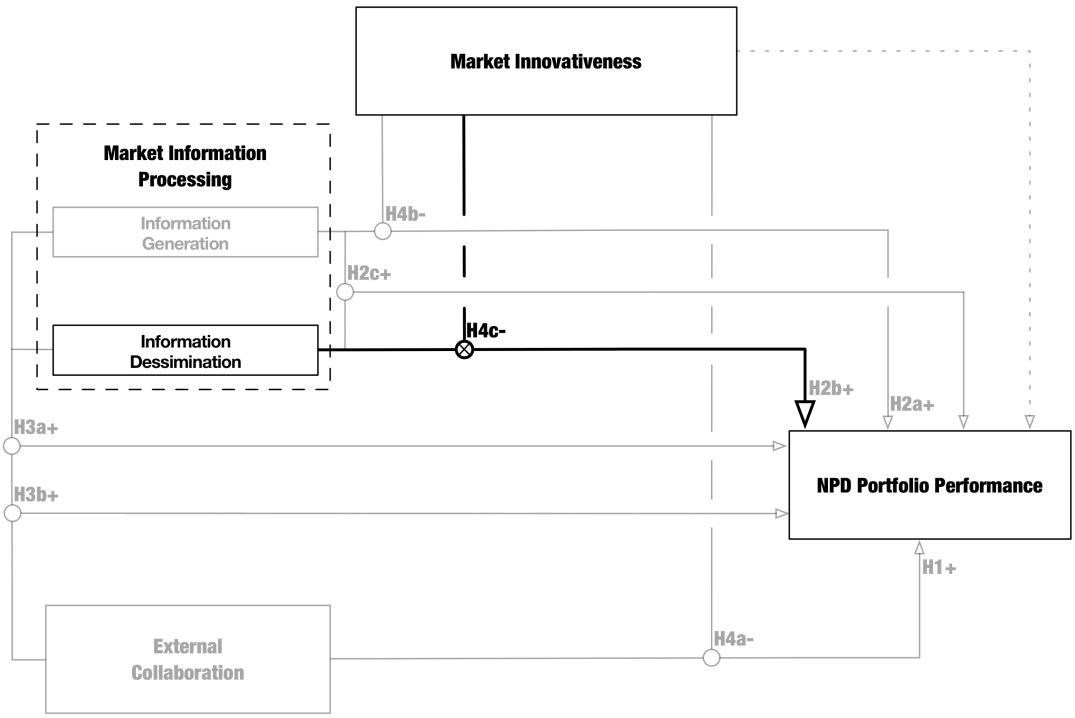


Figure 12. Market information dissemination and Market innovativeness Interaction on NPD portfolio performance.

3.1.4. Information Processing Capabilities as a Way to Handle Intensity of External Collaboration in NPD Projects

Hypotheses 4a, b, and c suggest that innovativeness is a key contingency in the NPD process due to the level of uncertainty it entails. Indeed, the relationships between the intensity of external collaboration and NPD performance and between market information processing and NPD performance appear to be moderated negatively by innovativeness. So far, however, little discussion exists about how external collaboration and market information processing capabilities interact and none at all, it seems, regarding the possible moderating effect of innovativeness on these constructs.

This study proposes that market information processing capabilities are a required capability for successfully identifying, generating, and disseminating information from external sources of innovation. However, the newer to the market a product is, the harder

it is for actors along the value chain to contribute constructively because they are embedded in the current product offerings. The new product might target entirely new customers, thereby making it difficult for existing customers to provide feedback. Current distributors might not be suitable for the new market. Suppliers might be challenged to provide the components needed.

These observations are in line with previous research by *Zhou et al., (2005)* that found that firms with a strong customer focus are better at technology-based innovation than market-based innovation. Technology-based innovations help fulfill latent unmet needs of the current customer base. Market innovations target entirely new market segments, which makes current market actors less relevant in the NPD process. The focus here is broader than that of *Zhou et al., (2005)* as it entails not only customers but a wide spectrum of market actors and the firm's capability for engaging with them in an NPD context.

Nevertheless, the *Zhou et al., (2005)* findings are compelling and to build on their line of argument, this study proposes that simultaneous external collaboration and market information generation is most effective with incremental market innovations. With incremental NPD projects, the input needed from external sources is more manageable within the organization because it relates to existing project lines or variations on them. Potential collaborators also become easier to identify and collaborate with for the NPD team when the level of uncertainty is low. All along the value chain, potential collaborators already possess a working understanding of product use and features, thus making it easier to tap into their information. Under these circumstances, a higher degree of market innovativeness makes it difficult for the organization to identify and acquire information from collaborators.

Hypothesis 5a. The combined impact of external collaboration and market information generation on NPD performance becomes weaker when the NPD program has a higher degree of market innovativeness.

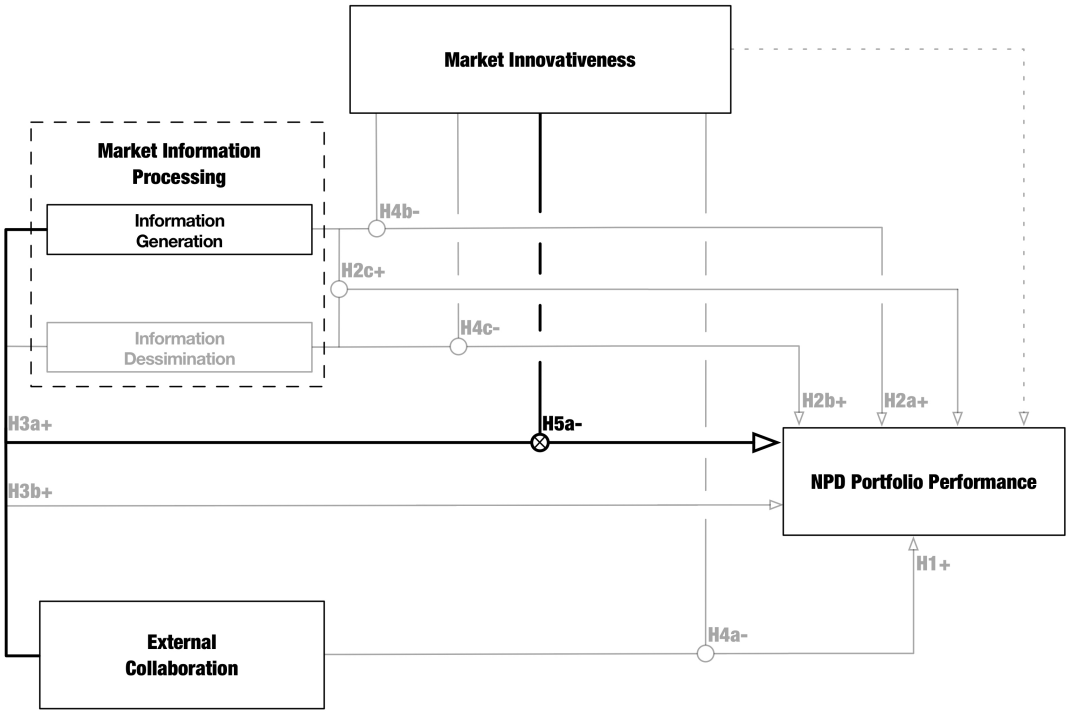


Figure 13. Intensity of external collaboration, market information generation and Market innovativeness Interaction on NPD portfolio performance.

The problems inherent in using market-based actors and information in the NPD process extend beyond the identification and generation of information from external collaborators to the dissemination of collected information throughout the organization. Given the increased uncertainty associated with NPD projects with a high degree of market innovativeness, the information generated by individual NPD team members from external collaborators is less likely to fit into the general information flow within the organization. As mentioned above, the information from external sources of innovation might be of a type that organizational members are not accustomed to processing. It is also likely that NPD projects that target new markets or customer segments have to take user preferences and requirements into account that have not previously been given attention by the firm.

In light of these obstacles, the likelihood of the NPD team facing organizational rigidi-

ties and opposition increases as the degree of market innovativeness within the NPD project rises. In this respect, *Leonard-Barton (1992)* identified core rigidities in the areas of knowledge, technology, management, and values that can manifest in NPD projects that have gaps between product specifications and market information. Technical barriers are among the easiest to resolve with regard to the requirements of NPD and may be the least expensive as well. Management systems and organizational values can prove harder to change as these are embedded within the organization's structure and its individual members. Indeed, new information might be disregarded if it is perceived as coming from sources of lower status or relevance.

Drawing on the study by *Zhou et al., (2005)* mentioned above, which argues that market information is most effective with regard to technical-based innovations, and on *Leonard-Barton, (1992)*, which illustrates how organizational rigidities might hinder success in NPD projects, this study argues that organizational rigidities to external input are far more likely to play a negative role when the firm is disseminating information in situations with high market innovativeness and uncertainty.

Hypothesis 5b. The combined impact of external collaboration and market information dissemination on NPD performance becomes weaker when the NPD program has a higher degree of market innovativeness.

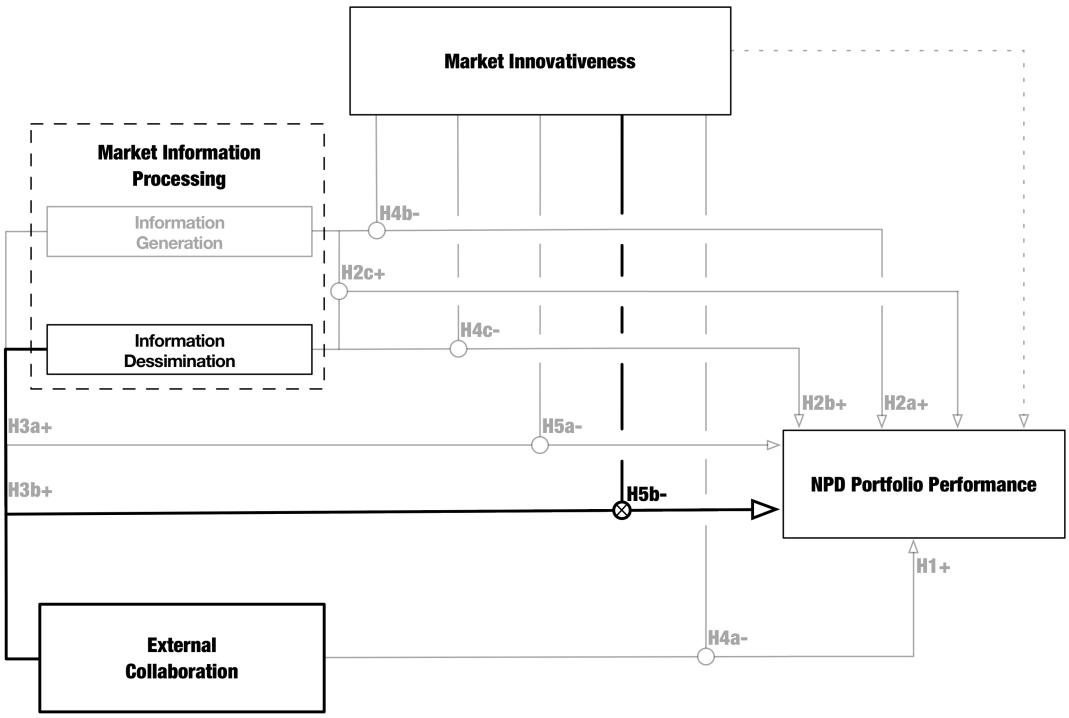


Figure 14. Intensity of external collaboration, Information dessimination and Market innovativeness Interaction on NPD portfolio performance.

3.1.5. Summary of Hypotheses

This chapter has presented the research hypotheses to be tested in the empirical study. The hypotheses focus on defining the nature of the relationship between external collaboration, market information generation and dissemination, and NPD portfolio performance (H1, H2a, H2b); testing the effect of combining external collaboration with market information generation and dissemination on NPD portfolio performance (H2c, H3a and H3b); testing the moderating effect of innovativeness on the firm's ability to benefit from external collaboration, market information generation, and market information dissemination (H4a, H4b and H4c), and, finally, testing the moderating effect of market innovativeness on the combined impact of external collaboration, market information generation, and dissemination on NPD performance (H5a and h5b).

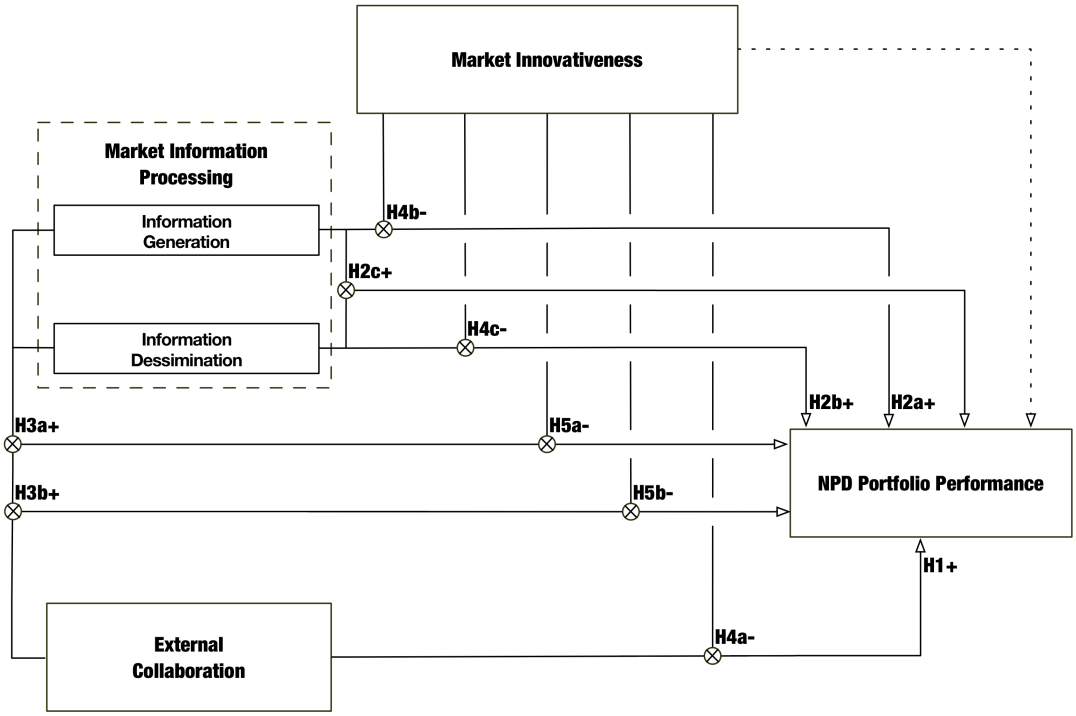


Figure 15. Complete conceptual model.

Chapter 4 - Empirical Study

In chapter 3, the research hypotheses were developed for the relationship between innovation strategy and firm-level performance, based on existing theory and empirical evidence in innovation research. A quantitative study was undertaken to test the hypotheses. The results of this study are presented in this chapter as well as the process leading to the outcome. The chapter starts with an operationalization of the variables conceptualized in the literature review and framed in the research hypotheses. The next section details the empirical research design and data used. The variables are then examined using descriptive statistics, factor analysis, and reliability tests. The final step in data testing is an examination of the correlations between the variables. The chapter concludes by addressing the common method bias.

4.1. Methodological Considerations

This study will apply some perspectives towards the positivistic end of the ontological continuum, by deducing a conceptual model from some empirical measures. Although the research topic explored in this study is inherently a social construct the measurement models employed are positivistic in nature. Hence, The research relies on positivistic methodologies such as quantitative data collection and deductive argumentation. The theoretical framework and the derived research questions control the collection of data for this thesis.

Like much of the management engineering research, I adopt the ontological approach of post-positivism. The post-positivism paradigm is therefore not just an amendment to the positivist paradigm but a radical change from the ideals proposed by Kuhn[206] of verification and the quest for certainty in knowledge and therefore in scientific theory. Instead, the post-positivist paradigm does not perceive scientific research as a quest for

[206] See Trochim and Donnelly, 2008

certainty; rather most contemporary social research looks for probabilities. Hence, the inferences made in social science based research have probabilities associated with them and are rarely meant to result in 'laws' that cover all cases. Many post-positivist engaged in social research therefore also identify with the critical realism[207] or the social constructivists[208] philosophies.

The rise of the post-positivist paradigm has also led to an increase in statistically based studies because this allows for the estimation of probabilities. However, because all measurement are imperfect, the post-positivist position is that multiple measures and observations are needed, each of which possess different types of errors. Using different measures with different error types, the researcher has a better opportunity to pin point whats is happening in reality. Furthermore, the post-positivist paradigm also highlights the importance of being aware of the inherent biases in perspective the researcher brings to the study. These biases are often related to culture and worldview, and in research they are often based on the theoretical framework employed by the practitioner. The researcher is, therefore, responsible for attempting to overcome theses biases and reach for a high a level of objectivity as possible. However, achieving the goal is unlikely. The post-positivist emphasize that the optimal way to achieve objectivity is through critical engagement and dialog with others.

Conducting this study from a post-positivist perspective implies several implications both in terms generalizability and validity of the findings. By applying statistical analysis as is common with the post-positivist paradigm I will attempt to address both the internal and construct of the study in the proceeding part of this chapter. Furthermore, I will discuss the generalizability and external validity in chapter 6 of this study — dis-

---

207 Social constructivists holds to the philosophy that reality is a conceptual construct. Within the constructivist paradigm the emphasis is placed on understanding how we construct the world. Constructivists can be either realists or subjectivists. The former believe in the presence of an external reality that the researcher imperfectly apprehend, while the latter believe that all constructs are mediated by subjective experiences.

208 Critical realism is the belief that there is an external reality indenpendent of the researchers preconceptions and beliefs, hence the realism. However, the researcher can never know reality with certain accuracy, which covers the critical part of the terminology.

cussion and implications.

4.2. Research Design

A typical shortcoming of studies testing success relationships is common method and common source bias. Both biases occur when the dependent variable and the independent variables are measured using the same method, such as the survey data employed in this study, and by asking the same source. To meet this methodological challenge, the dependent variable, NPD portfolio performance, was only measured via a senior manager while all other indicators were measured using NPD team members. Using different respondents for the dependent and independent variables addresses common source and common method bias.

Another methodological challenge to overcome is the time lag between the execution of the NPD process to the time the NPD results can be measured in the firms financial metrics. Some authors resolve this problem by waiting several years after completion of the survey before retrieving firm performance data. This study chose a different approach; The respondents were asked to consider the ongoing NPD projects and NPD portfolio performance over a three-year period. This study, therefore, provides a snapshot of the firms NPD activities and results on a portfolio level rather than focus on the processes and outcomes of a single NPD project.

Partial models, as the one in this study, face the challenge of not considering all factors impacting the NPD performance construct. Besides the intensity of external collaboration and information processing capability, there are other important factors influencing a firm's performance. This study includes the contingency of market innovativeness and several control variables, to account for some of the other factors affecting performance. Moreover, this study builds on well-established measures to the maximum extent possible. Some measures were modified to fit the context of this study, e.g., the intensity of external collaboration, to ensure that highest possible level of validity and replicability. The constructs are determined thorough literature review and linking the chosen con-

structs to the existing research. Furthermore, the breadth of the content of a certain construct needs to be thoughtfully assessed. For this study, this was ensured by the measurement of all survey-based constructs a 5-point-Likert-scale was used.

The following chapter list and describe all measures for all constructs.

4.2.1. Sample

A cross-sectional sample of technology-oriented firms located in Denmark and Austria was used. As part of a benchmarking study, data was collected to investigating issues of managing NPD programs. Only firms active in their markets for at least five years were targeted. Potential participants were identified based on industry directories, participant lists of specific industry conferences, and memberships of professional organizations. These firms were contacted by direct mail to senior management, explaining the objectives, respondent benefits, and procedures of the study. Interested firms were contacted over the phone to verify that they met the participation requirements and offered the opportunity to participate in the survey. The firms were charged for involvement in the benchmarking study. Hence, while the benchmarking was initiated externally of the participating firms, it was driven by top management's wish for a precise picture of the firm's innovation process- and NPD management capabilities. This commitment on behalf of the participating firms to pay for participation indicates that both management and employees spend significant time to answer the survey. Furthermore, the respondents did not answer in an altruistic effort to assist scientific endeavors, but to improve internal innovation management competencies.

Firms nominated an employee responsible for coordinating data collection within the firm. This coordinator identified the key informants, including at least one senior manager and approximately six employees actively involved in the NPD program of the firm. For the actual data collection, two different groups of respondents were used as sources of information about the independent and the control variables. Top manage-

ment (CEO) or heads of R&D or Chief Technology Officers (CTO) about NPD portfolio performance, and NPD team members about the control and independent constructs. All pre-selected respondents were contacted by email and provided with an access code to an online questionnaire. The final sample used in this study included 1,179 respondents from 263 firms, where each firm had at least three different respondents with no missing values concerning the item list. 263 respondents held senior management positions (CEO-level), and at the NPD team level 910 were involved.

INDUSTRIES	NR. FIRMS IN SAMPLE
Agriculture	1
Utilities	5
Construction	14
Manufacturing	143
Trade	19
Retail	5
Transport	1
Information	4
Finance	8
Real Estate	2
Professional Service	36
Management	10
Support Services	5
Education	4
Health Care	1
Arts & Recreation	1
Accommodation	1
Public Administration	1
Other Services	2
Total	263

Table 4. Firms divided by industry.

The overall sample used in this study consist of 263 firms divided across 19 industries

within Denmark and Austria. The majority of cases 55% was drawn from manufacturing firms while the remaining 45% was spread across service, information, financial and education sectors.

4.3. Operationalization of Variables

Developing a measurement model is a methodological exercise requiring the same amount of rigor as that needed for developing hypotheses. Clear conceptual definitions of the constructs are established and construct measures are calculated and considered before any analysis is conducted. It is critical that the conceptualization and operationalization of a construct match. With reflective constructs the causality flows from the construct to the indicators: This means that the indicators are caused by the construct. Hence, the indicators are the manifestations of the construct. Classical test theory concludes that the variation in scores on measures of a construct is a function of the true score plus error. The underlying latent variable "causes" the observed difference in the measures. In this case, the measures are expected to be highly correlated. Hence, internal consistency reliability is necessary. The questionnaire items used to measure the construct are assumed to be a sample of the population of all potential measures, such that they have similar content, e.g., that is; they are unidimensional. Furthermore, they have to be functionally interchangeable, and dropping an indicator from the measurement model of a reflectively measured latent variable does not alter the meaning of the construct.

The assumed direction of causality of reflective studies is conceptually suitable in many cases, but not for all. For some constructs, the reverse causal direction is more conceptually sensible, e.g., causality flows from the measures to the construct. This type of construct is often referred to as composite latent variables because they are often a multidimensional composite of different measures representing a collection of various behaviors or concepts. However, those measures need not be interchangeable. Thus, in a formative indicated construct, the measures do not necessarily need to be correlated, although they may be.

Given that the items from the survey used in this study directly reflect the conceptual construct this study is trying to measure, a reflective approach was used, e.g., for intensity of external collaboration the respondents were asked "how much do you use suppliers in the NPD process".

To operationalize the different topics of this study, the following criteria were applied:

- **The use of action oriented constructs:** For each construct it should be possible to associate concrete actions taken within the firm. This means that very abstract dimensions relating to perceptions rather than actions are not considered. Such constructs might provide a more holistic perspective. However, action-oriented constructs are easier to validate by asking or observing concrete actions.
- **The use of established constructs:** Already established constructs within external collaboration in NPD research should be considered if this research promises to add new insights. The 'market orientation' construct of *Kohli and Jaworski (1990)*, for example, has been extensively researched on its own, and examining it again does not promise to add significant new insight[209].
- **New aspects and constructs:** New trends within the different streams of research into the intensity of external collaboration in NPD should also be reflected in this study. This does not only mean potentially adding entirely new constructs, but also modifying and extending existing constructs from the literature.
- **Meaningful at firm level:** The perspective of this study is the firm. Concerning external collaboration in NPD, this means that the entire NPD project portfolio is examined, not only single projects. Only constructs are included in the study with a portfolio perspective makes sense and promises to yield differentiated results.

4.3.1. NPD portfolio performance

[209] See Kohli and Jaworski (1990); Maltz and Kohli (1996); Veldhuizen, Hultink, and Griffin (2006).

Numerous studies have explored the innovation performance measures, and researchers have long acknowledged that it is difficult to choose suitable indicators to measure the NPD performance of firms [210]. As there is still no consensus on an innovation performance index, innovation performance is measured using three indicators in this study. By drawing recommendations from previous research: the proportion of annual turnover of new products, new products index and modified products index. *Brettel and Cleven (2011)* operationalized product innovation performance by measuring the frequency of market launches of new products, the innovation publicity generated by the firm, the degree of novelty of new products and the percentage that new products represent in the product portfolio and the sales volume. *Lau, Tang, and Yam (2010)* equated customer and supplier integration with new product performance. In this study I adopt the approach used by *Laursen and Salter (2006)* who used a measure who used a variables for NPD performance linked to turnover of products new to the world market, turnover pertaining to products new to the firm and turnover relating to products significantly improved[211].

Since the overall purpose of this study is to measure the extent of which the use of external collaboration and market information processing in the innovation process has a positive effect on NPD performance, the financial performance of the innovation portfolio of the firms is considered a solid measure. However, Objective performance data, can be difficult to acquire and may be difficult to interpret in the context of a dataset where the size of the firm vary along with their industry and geographical location. I, therefore, use I used self-reported measures from the sample firms managers to measure financial performance[212].

---

210 See Romijn and Albaladejo (2002).

211 e.g., Belderbos, Faems, Leten, and Looy (2010); Hoyer, Chandy, Dorotic, Krafft, and Singh (2010).

212 See Stam (2009).

Also In line with previous research, a multi-item approach is used[213]. Three items is included to measure the performance of the innovation portfolio over three years: profitability, market share and sales. Instructional phrases to the financial parts of the questionnaire emphasized that responses should be given considering the entire new product portfolio. This phrasing was applied to prevent too average and thus similar answers. Asking for a portfolio perspective inherently bears the challenge of average responses. The problem is not entirely avoidable. However, asking for an assessment of the majority of NPD proved to result in differentiated answers. These financial indicators measures investigate the economic impact of the firms NPD activities and are therefore important when deriving recommendations for both researchers and practitioners.

NPD Portfolio Performance	
Increased markershare. Increased sales. Increased revenue.	Adopted from: Brettel & Cleven, (2011); Laursen & Salter, A. (2006); Zeng, Xie & Tam,(2010).

Table 5. NPD Portfolio Performance.

4.3.2. Intensity of External Collaboration in NPD

The literature on the use of external collaborators is vast and covers a broad range of activities as discussed in the literature review. As discussed in the literature review, previous research has either looked at a single aspect of external collaboration[214] or looked at the interaction between different aspects[215]. In this study, I am interested in the aggregated effect of the intensity of external collaboration on NPD performance. Intensity of external collaboration is therefore treated as a single construct composed of 5 different items from the survey, i.e., collaboration with customers, suppliers, etc. However, much of the external collaboration literature show that not all potential external sources are of

213 See Griffin and Page (1996).

214 e.g., Foss, Laursen, and Pedersen (2011); Jeppesen and Frederiksen (2006); Gnyawali and Park (2011).

215 e.g., Miotti and Sachwald (2003); Nieto and Santamaría (2007).

equal value to the NPD process. For example, in this study no distinction is made between the terms user and customer. The user-driven innovation school, in particular, distinguishes between regular customers and lead users[216]. This argument highlights that some users have the need and competencies to adapt or modify existing products to their needs. These users have the qualifications to contribute to firm hosted NPD projects since their expertise reaches far beyond the average customer. Likewise, literature into supplier collaboration indicate that not all suppliers are created equal when it comes to contributing to an NPD process [217]. While these results highlights the difficulty of identifying the most insightful collaborators the construct used in this study measures the overall effect of the firm's use of external sources and also the intensity of the collaboration. It, therefore, presents a view of the intensity of the firms external collaboration activities as a whole rather than a more detailed look at the sub-dimensions comprising the construct.

For the operationalization of the intensity of external collaboration construct measures from previous studies with a broad perspective and large sample, quantitative studies were adopted[218]. This approach, while not identical, is inspired by the work of *Laursen and Salter (2006)* which measured external collaboration in NPD along 16 different dimensions divided into 4 different types; Market, institutional, specialized and others. In this study, I conceptualize the construct of external collaboration along similar dimensions of collaboration with customers, competitors, suppliers, universities and others. Also, *Laursen and Salter (2006)* used the term 'depth' to indicate the intensity of the firms collaboration efforts. The survey items used for the operationalization of this construct likewise measures the intensity of collaboration with the different external sources on a 5 point Likert-type scale; with 1 representing no collaboration with collaborator and 5 representing intense collaboration with the given external source.

---

216 Baldwin and von Hippel (2011); Droge, Stanko, and Pollitte (2010).

217 Petersen, Handfield, and Ragatz (2005); Schiele (2010).

218 Un, Cuervo-Cazurra, and Asakawa (2010); Brettel and Cleven (2011); Belderbos, Faems, Leten, and Looy (2010).

Intensity of External Collaboration	
Intensity of collaboration in NPD with customers. Intensity of collaboration in NPD with competitors. Intensity of collaboration in NPD with suppliers. Intensity of collaboration in NPD with public institutions. Intensity of collaboration in NPD with other market actors.	Adopted from: Brettel & Cleven, (2011); Laursen & Salter, A. (2006); Un, Cuervo-Cazurra, & Asakawa, (2010).

Table 6. Intensity of external collaboration.

4.3.3. Market information processing

There is a substantial amount of literature detailing the effect of market information processing on firm performance[219]. However, while the market information processing approach covers many of the external collaborators it does not handle supplier, University, and other research related actor. I use this perspective to identify key capabilities needed for firms to identify, process and disseminate information from outside sources. However, the traditional approach to measuring market information processing follows to lines of reasoning. The first approach measures the firms market information processing capability as a single multidimensional construct[220]. The second approach measures it along three dimensions; Information generation, information dissemination, and information use. However, In this study I reject the first approach. The multi-dimensional nature of a single market information processing construct allows for an interpretable effect of firms overall capability to handle information. However, it does not give an adequate picture of the different capabilities the concept of information processing covers. A firm might be skilled at collecting information but lack the structure and culture to effectively disseminate it throughout the organization. The second approach, however, includes information use as the final step in information processing, and previous literature has indicated that this is the step where information is internalized and trans-

219 Slater and Narver (2000).

220 Narver and Slater (1990); Kohli and Jaworski (1990).

ferred into knowledge. Also, previous research has found indications of the effect of information quality impacts the information processing and performance relationship[221]. Since the transformation of information into knowledge is outside the scope of this dissertation, and the dataset does not support analysis of information quality, I do not include information use among the information processing variables in this model. Instead, I focus on the firms ability to collect information and disseminate and measure this as two separate constructs.

Also, little research has been conducted into how the elements of market information processing interact synergistically[222]. Moreover, the literature lacks sufficiently research at this point on if and how interdependencies between the market information processing activities complement each other to produce successful NPD successes[223]. From a practical perspective, the different activities that amount to the information processing capability of the firm might be hard to separate. The problem of distinguishing the variables might go some way in explaining the lack of attention has been given as to the interdependencies of these conceptually distinct and functionally different types of activities.

4.3.3.1. Market Information Generation

A key challenge for firms is the identification and acquisition of information from external sources, especially in NPD[224]. Previous research has directly and indirectly been conceptualized market information as a temporal activity[225], where information must be collected before it can be disseminated. Hence, this study starts the information processing construct by including the concept of market information generation. Information generation is defined in this study as members of the NPD teams efforts to identify and

---

221 Ottum and Moore (1997).

222 Moorman (1995); Ottum and Moore (1997).

223 See Hultink, E. J., Talke, K., Griffin, A., & Veldhuizen, E. (2011).

224 Zhou, Yim, and Tse (2005); Han, Kim, and Srivastava, R. (1998).

225 Moorman (1995); Ottum and Moore (1997).

acquire market information to enhance their understanding of NPD challenges. The importance of information generation has been having been highlighted in the literature a result of NPD team members ascribing a higher value to information from the market than from internal sources[226]. Based on indicators for information generation used in previous studies I use the following three items for the questionnaire to develop the construct.

MARKET INFORMATION GENERATION	
We define a set of criteria for which market actors should be examined. Based on thorough analysis insightful market actors are selected for further interview. We collect market information through methods which ensure a comprehensive picture of the market.	Adopted from: Veldhuizen, Hultink,& Griffin (2006); Hultink, E. J., Talke, K., Griffin, A., & Veldhuizen, E. (2011).

Table 7. Market information generation.

4.3.3.2. Market Information Dissemination

As the information, generation constructs the role information dissemination is a well-established construct[227]. However, previous studies have shown that the effect of information dissemination is often hard to demonstrate in empirical research. *Hultink, Talke, Griffin, Veldhuizen (2011)* speculated that the effect of information dissemination on performance might be related to information quality, how the information was used at a later stage, and, therefore, hard to capture within an empirical study. In an attempt to counter this measuring problem I operationalize information dissemination by including items that captures both the formal structures in place within the firm to facilitate the spread of information and the informal culture which facilitates the flow of information[228].

---

226 Leonard and Rayport (1997).

227 See Maltz and Kohli (1996).

228 See also Kohli and Jaworksi (1993).

MARKET INFORMATION DISSEMINATION	
We regularly share ideas and concerns from customers. We have effective systems for information sharing in the organization. A large part of the informal communication are about our competitors strategies. We hold regular meetings to discuss market trends	Adopted from: Veldhuizen, Hultink,& Griffin (2006); Hultink, E. J., Talke, K., Griffin, A., & Veldhuizen, E. (2011).

Table 8. Market information dissemination.

4.3.4. Market Innovativeness

In this chapter, the concrete indicators measuring market innovativeness in the written survey are introduced. Innovativeness is an established construct in innovation research. It is traditionally treated as a second-order construct consisting of two dimensions: market innovativeness and technology innovativeness. However, in this study the focus is on the relationship between the firm and its external collaborators and market innovativeness is included as the primary contingency. Previous research has shown newness to the market as a major challenge for collaboration with most of the actors discussed in this study[229].

The market innovativeness construct was adopted from established indicators. No new items had to be developed. However, existing indicators needed to be adapted for the firm level given the majority of studies on innovativeness take place at the product or project level[230]. To account for this difference the items were rephrased from a single NPD project to the entire new product portfolio of the firm. Moreover, introductory phrases in the questionnaire emphasized that answers should be given considering the whole new product portfolio. More specifically, the respondents were asked for a judgment of the majority of a firm's NPD projects. This phrasing was included to prevent from the respondents given too similar answers. Asking for a portfolio perspective in-

229 See Han, Kim, and Srivastava (1998).

230 See Garcia and Calantone (2002); Cillo, De Luca, and Troilo (2010).

herently bears the challenge of average answers. The problem is not entirely avoidable. However, asking for an assessment of the majority of innovations proved to result in differentiated responses.

Concerning individual indicators established items were selected which covered the full breadth of the market innovativeness construct and addressed distinct aspects of newness to the market. Table 9 gives an overview of the used items as well as their sources. For market innovativeness the six indicators address innovativeness from three levels: *(a)* new benefits or advantages to the customers, *(b)* changes to the firm's markets, *(c)* and changes to the firm's industry.

MARKET INNOVATIVENESS	
Our new products/services provides new value from customers thats not been possible before. Our new products/services has created a whole new market. Our new products/services has significantly changed the market mechanisms. Our new products/services has significantly changed the value chain in our industry. Our new products/services has attracted new customers not previously served by our industry. Our new products/services can be characterized as very new to the market.	Adopted from: Garcia & Calantone (2002); Hultink, Talke, Griffin & Veldhuizen,(2011).

Table 9. Market Innovativeness.

4.3.5. Operationalization of Control Variables

Given that the focus of this study is the relationship between the NPD portfolio performance and external resources used in the innovation processes several factors have been identified that influence the innovation processes. To this end, six control variables have been selected:

1. The impact on the firm's ability to use external resources and their ability to monitor the market is firm size. A large body of work attributes firm

size to different behaviors and outcomes in the innovation process[231]. Previous research has shown that small and medium-sized firms tend to focus more on product innovation than their larger counterparts, who tend to prioritizes process innovation[232]. It is, therefore, more likely that small and medium-sized firms will display a higher degree of market innovativeness about their market than larger firms. However, research also indicates that a firm's performance is closer linked to the quality of its external network than to its size[233].

2. To control for the national origin of the firm a dummy variable is used to account for responses from two different geographical locations in Denmark and Austria.
3. The level of organization's formalization might play a role in a firm's ability to utilize input form external actors as well as their capability for collecting and disseminating market information. Several other papers have explored the relationship between formalization and NPD performance using the same dataset so for this reason the control for the effects of formalization in the decision-making process[234].
4. This construct comprises both the aspect of market and technology turbulence respectively. Turbulence, whether in the form of a change in the market conditions or the technology underpinning the industry may represent a distortion in the firm's ability to gather and utilize information in the NPD process[235]. In other words, the presence of turbulence may limit the firm's ability to engage with external resources in their innovation process. The observed relationships between the firm's collaboration with external resources and their ability to gather information about the

231 See Cohen and Klepper (1996); Nooteboom (1994).

232 See Fritsch and Meschede (2001).

233 See Nieto & Santamaría, 2010.

234 e.g., Schultz et al., 2013,

235 See Calantone, Garcia, and Dröge (2003); Zhou, Yim, and Tse (2005).

market could be significantly affected by the turbulence of their market and technology space.

5. I also test whether or not the firms focus on either business customers or end consumers as this might impact how they interact with their market, process market information and choose external collaborators. Moreover, within parts of the external collaboration literature is a discussion on the impact of users vs. the impact of customers. In this study, I use customers as a generic term for the end consumer of the product and find in the literature that the use of customers is a much-debated subject with conflicting findings. The user driven school of external collaboration in NPD research, however, distinguishes between regular customers and lead users. The latter has a professional interest in adapting and improving the product and is, therefore, more valuable as collaborators in NPD[236].

6. Finally, I include the measure of technological innovativeness. One of the main contributions of this paper is newness to the market and how this impacts the relationship between external collaboration, market information processing, and NPD portfolio performance. Previous research has demonstrated the a complex relationship between technological innovativeness and commercial success[237].

---

236 See Morrison, Roberts, and Midgley (2004).

237 See Kock, Gemünden, Salomo, and Schultz (2011).

CONTROL VARIABLES	
Firm Size	Van de Vrande, de Jong, Vanhaverbeke,& de Rochemont, (2009); Van de Vrande, de Jong, Vanhaverbeke & de Rochemont, (2009).
Country	Independently developed measure
Formalization	Adopted from Schultz, Salomo, de Brentani & Kleinschmidt, (2013).
Customer focus B2C B2B	Independently developed measure
Technology Turbulence	Jaworski & Kohli (1993).
Technology Innovativeness	Garcia & Calantone (2002)

Table 10. Control variables.

4.4. Descriptives Statistics

The methodology applied in this study to test the hypotheses is a hierarchical regression analysis, with a multivariate approach. Results from these more complex models are preceded by descriptive statistics for each of the constructed variables. In the descriptive statistics, a univariate approach was used to describe the type and structure of the variables used in the sample, such as mean, frequencies, etc. Also, the data was checked for the normality of the distribution using skewness and kurtosis values. In Table 11 an overview of the firms distribution by size is presented.

FIRM SIZE	CASES	PERCENT
Small [< 50]	37	13,4%
Medium [51 - 250]	55	19,9%
Large [251 -1000]	76	27,4%
Very Large [>1000]	95	34,3%

Table 11. Firm size.

4.4.1. NPD portfolio performance construct

The operationalization of the NPD portfolio performance construct is measured as the impact of NPD on market share, revenue, and sales. This construct refers to firms' entire new product portfolio calculated at the mean and, therefore, represent averages across the whole portfolio within a three-year span.

VARIABLE	N	x_{MEAN}	SD	x_{MIN}	x_{MAX}
NPD Portfolio Performance	263	3.8745	.64376	1.50	5.00
Increased marketshare	256	3.6467	.64170	1.00	5.00
Increased sales	255	3.8736	.57547	1.00	5.00
Increased revenue	254	3.7106	.57449	1.00	5.00

Table 12. NPD portfolio performance descriptives.

With a mean of 3.87, when the maximum value is 5, the firms in the sample show that on average NPD has a significant effect on the long-term effect of the firms financial performance. Also, with an average standard deviation of .6 the firms in the sample all have significant financial benefits from their NPD portfolio activities.

4.4.2. The Intensity of external collaboration construct

The operationalization of the intensity of external collaboration is measured as the average of the mean level of collaboration intensity with the five different types of collaborators.

VARIABLE	N	x_{MEAN}	SD	x_{MIN}	x_{MAX}
Intensity of External Collaboration	271	2.6024	.56560	1.30	4.70
Intensity of collaboration in NPD with customers	270	3.6221	.83198	1.00	5.00
Intensity of collaboration in NPD with competitors.	271	1.7014	.71449	1.00	5.00
Intensity of collaboration in NPD with suppliers.	270	3.1278	.80385	1.00	5.00
Intensity of collaboration in NPD with public institutions.	261	2.2710	.80267	1.00	5.00
Intensity of collaboration in NPD with other market actors.	267	2.4719	.88119	1.00	5.00

Table 13. Intensity of external collaboration descriptives.

With a mean of 2,6 the firms in the sample show a below average intensity of external collaboration; however the spread among the individual items comprising the construct is quite large. On average the intensity of external collaboration with customers is high (3.6) indicating it is something the firms in the sample has a high degree of close collaboration with customers. Collaboration with universities and other external sources are relatively low at 2.2 and 2.4 respectively. Surprisingly, when compared to the literature on collaboration intensity with competitors is at 3.1, which the literature indicates should be the most problematic. Collaboration intensity with suppliers, however, is low at 1.7, which the literature indicates should be among the easiest due the supply chain integration.

4.4.3. Market information processing

Market information processing in this study was conceptualized as a 2nd order factor consisting of two 1st order factors; Information generation and dissemination.

4.4.3.1. The Information generation construct

VARIABLE	N	x_{MEAN}	SD	x_{MIN}	x_{MAX}
Market Information Generation	271	2.8144	.72324	1.00	4.60
We define a set of criteria for which market actors should be examined.	267	2.8695	.88533	1.00	4.20
Based on thorough analysis insightful market actors are selected for further interview.	267	2.8998	.88340	1.00	5.00
We collect market information through methods which ensure a comprehensive picture of the market.	259	2.7898	.87296	1.00	5.00

Table 14. Market information generation descriptives.

The market information generation construct covered the firms ability to set collaborator selection criteria, screen potential collaborators, and the methods used for the collaboration. With an average mean of 2.8 the firms in the sample show slightly below average market information generation. The descriptive statistics indicate that while the firms engaged in market information generation they did not place a significant high

value on controlling the selection, screening, and collaboration method. Since all these items had mean values similar to the average and the standard deviation for all were .8 or less.

4.4.3.2. The information dissemination construct

VARIABLE	N	x_{MEAN}	SD	x_{MIN}	x_{MAX}
Market Information Dissemination	271	3.3392	.64671	1.30	5.00
We regularly share ideas and concerns from customers.	270	3.3437	.77740	1.00	5.00
We have effective systems for information sharing in the organization.	269	3.3768	.78458	1.00	5.00
A large part of the informal communication are about our competitors strategies.	271	3.3323	.81666	1.00	5.00
We hold regular meetings to discuss market trends	270	3.2813	.78652	1.22	5.00

Table 15. Market information dissemination descriptives.

The overall high mean of the market information dissemination construct of 3.3 is driven by all four of the survey items. The descriptive statistics indicate that firms in the sample are relative active in spreading and sharing information both through structured formal channels and informal encounters. With no significant difference between the two mean values for formal and informal dissemination, the firms within the sample appears to value both equally.

4.4.4. The market innovativeness construct

Market innovativeness is the average of the firm's innovation portfolio during the three years prior to participating in the study. Based on previous studies[238] a scale was developed composing five items covering different aspects of innovativeness: newness to market, significant change in market, significant change in the industries value chain, the products ability to create new jobs and attract new customers not previously serviced by the industry. The construct was measured as a first order factor.

238 Atuahene-Gima (1995); Souder and Song (1997).

VARIABLE	N	x_{MEAN}	SD	x_{MIN}	x_{MAX}
Market Innovativeness	271	2.8313	.68364	1.00	5.00
Our new products/services provides new value from customers thats not been possible before.	271	2.8048	.90701	1.00	5.00
Our new products/services has created a whole new market.	267	2.3072	.80707	1.00	5.00
Our new products/services has significantly changed the market mechanisms.	269	2.4969	.75477	1.00	5.00
Our new products/services has attracted new customers not previously served by our industry.	270	2.9533	.85885	1.00	5.00
Our new products/services can be characterized as very new to the market.	271	2.7047	.94884	1.00	5.00

Table 16. Market innovativeness descriptives.

With a mean of 2.8, when the maximum possible value is 5, the firms in this sample show an average innovative product portfolio. When examining the individual items that change in customer composition is more pronounced (2.9) than a change in the current market (2.3). The descriptive statistics indicates that within the market innovativeness construct the effect of attracting new customers in the current market environment is more pronounced than actually opening entirely new markets. This is in line with previous research which indicates that the process of opening a new market has a greater degree of uncertainty associated with it than expanding the customer base[239].

4.4.5. The control constructs

The firms in the sample show a slightly above average level of formalization. Given that the level of formalization has previously been linked to firm size[240], the spread of firms in the sample across size. With a wide variety of different industry, it is not surprising

239 Cooper (1979); Kleinschmidt and Cooper (1991).

240 Donaldson (2001).

that the mean value across the sample for formalization falls somewhere in the middle. Furthermore, the B2C focus also indicates an average focus on consumer customers but with a large standard deviation of 1.7. The focus of B2B has a mean of 4.1 indicating a strong focus within the sample firms on other businesses as their customer base. The

CONTROL VARIABLES	N	x_{MEAN}	SD	x_{MIN}	x_{MAX}
Firm Size (categorical variable)	263	2.87	1.059	1.00	4.00
Geography (dummy variable)	277	.60	490	0.00	1.00
Formalization	271	3.235	1.0939	1.00	5.00
Turbulence	264	2.580	.5752	1.00	4.50
Customer Focus					
B2B Focus	214	2.9221	1.70283	1.00	5.00
B2C focus	245	4.162	1.2997	1.00	5.00
Technological Innovativeness	271	2.931	.7709	1.00	5.00

Table 17. Control Variables descriptives.

turbulence construct was a combined measure of both the technology and market turbulence experienced by the firm but with a mean of 2.5 it does not appear to have a profound impact on the firms in the sample. Finally, technological innovativeness of the NPD projects was added for model completeness but given the spread in both firm size and industry of the firms sampled it was unsurprising that this construct exhibited a moderate relevance.

4.4.6. Outliers

Examining data for outliers is a common step in analyzing data. Outliers are any observation with a unique combination of characteristics identifiable as distinctly different from the other observations[241]. Moreover, there appears to be a great amount of confusion and misinformation regarding the appropriate method for detecting outliers. Using SPSS histogram, boxplots and distance between the mean and 5% trimmed mean was

241 See Hair et al. (2010).

evaluated for initial identification of outliers. Results were confirmed using the 'outlier labeling rule'[242]. Outlier labeling assumes that the analyst will try to investigate any observations flagged as outside the normal distribution and is the usable if the data is normally distributed, as is the case in this sample. The outlier labeling rule detects outliers based on multiplying the Interquartile Range (IQR) by a factor of 2.2, thereby giving you unique values for each variable that cases should not fall below or above[243]. In this sample, four outliers was identified across all variables. All of which had very low values of NPD portfolio performance, indicating that their NPD activities were either minor or that the impact of these on their market share, sales and revenue was miniscule. Furthermore, These cases also exhibited significantly lower levels of market information collection than the rest of the sample. *Hair et al., 2010* identified four cases of outliers; procedural error, extraordinary events, extraordinary observations or observations that are unique in their combination of attributes. Since the outliers identified here fall with the third and fourth category, the questions then remain if these cases should be retained or deleted from the sample. Due to their impact on the sample the outliers were removed.

4.5. Item reliability & Validity

When testing for the validity of the construct employed in this study two overall approaches are used. First, I test for the constructs internal validity by checking the consistency of the items that make up the constructs. The item reliability test is begun by running a confirmatory principal component analysis to test whether the relationship between the survey items selected for the constructs is suitable for use in the same variable. This is followed by a check of the convergent validity and the finish with an examination of the discriminate validity.

The second step concerns the relationship of the constructs to one another. To avoid multicollinearity problems that might influence the regression analysis applied later in

242 See Tukey (1977).

243 See Hoaglin, Iglewicz, and Tukey (1986); Hoaglin and Iglewicz (1987).

the chapter, the correlations between the different construct is checked. Ideally the independent constructs should correlate highly with the dependent construct but less so with one another. Since the correlation matrix only gives indications for multicollinearity problems the *variance inflation factor* (VIF) is checked to quantify the severity of any problems. The VIF results are verified using condition indexing. The condition index is a measure of near-dependencies that is a strong indicator of multicollinearity problems.
As the number of variables to be considered in multivariate techniques increases, so does the need for increased knowledge of the structure and interrelationships of variables[244]. Since the impact of external collaboration, the firms information processing capabilities and the level of market innovativeness have been used in previous studies (as described above). With confirmatory principal component analysis, the researcher must specify both the number of variables that exists for a set of variables and which factor each variable will load on before results can be interpreted. The confirmatory principal component analysis, therefore, allows for the conformation or rejection of factors loaded based on theoretical propositions or previously conceived variables. *Hair et al., (2010)* recommends retaining items with factor loadings of .70 or higher that load on eigenvalues above 1.0. In this way, the shared variance between an item and a construct exceeds the one between the construct and the error variance[245].

To test the convergent reliability of the overall construct Cronbach's Alpha and Average variance extracted (AVE) scores were calculated for each construct. Convergent validity is defined as the degree to which multiple attempts to measure the same concept are in agreement. *Hair et al., (2010)* recommends a cutoff point of .70 for Cronbach's Alpha scores, Also, AVE was calculated for each construct. AVE is a statistic that states how much variance captured by the construct in a model is shared among other constructs and the recommended cutoff point is .50. An AVE of less than .5 indicates that, on average, more error remains in the items than the variance explained by the factor.

---

244 See Hair et al., 2010.

245 See Woolridge (2009).

As a last test for measure validity, two checks for discriminate validity is applied. Discriminate validity is defined as the degree to which measures of different concepts are distinct from one another and correlate significantly with their intended constructs.

The use of previous measures helps mitigate on of the main drawbacks of PCA, which is the *'garbage in, garbage out'* problem. This problem arises because any factor analysis type test will always produce factors from a given dataset. However, without some framework for evaluating the conceptual validity of the factors the dimensions have not been reduced in a satisfactory manner, to a smaller, valid and workable set of variables.

This approach is used for increasing both the validity and the replicability of the model.

VARIABLE	KMO	BARTLETT'S TEST
NPD Portfolio Performance	.654	.000
Intensity of External Collaboration	.675	.000
Market Information Generation	.717	.000
Market Information Dissemination	.707	.000
Market Innovativeness	.858	.000

Table 18. Factor analysis suitability scores.

4.5.1. NPD Portfolio Performance

NPD PORTFOLIO PERFORMANCE	FACTOR LOADINGS	CRONBACH'S ALPHA	AVERAGE VARIANCE EXTRACTED
[Perf1] Increased markershare.	.901	.816	.69
[Perf2] Increased sales.	.899		
[Perf3] Increased revenue.	.844		

Table 19. NPD portfolio performance construct validity.

Inspection of the correlation matrix revealed that all coefficients were .4 or above indicating that a Oblimin rotation was more suitable than Varimax. The suitability of PCA was assessed prior to analysis . The Kaiser-Meyer-Olkin (KMO) measures was .654 thereby exceeding the recommended minimum of 0.6 recommended by *Kaiser (1974).* Bartlett's test of sphericity was statistically significant for the construct ($p < .000$), indicating that the data was suitable for PCA. All factor loadings were above the recommended .70 and both the Cronbach's Alpha score and AVE value exceeded their cutoff points of .70 and .50 respectively. With an eigenvalue of 2.200 on a single component the results of this analysis support the use of the NPD portfolio performance construct.

4.5.2. Intensity of External Collaboration

Intensity of External Collaboration	Factor Loadings	Cronbach's Alpha	Average Variance Extracted
[EC1] Intensity of collaboration in NPD with customers.	.856	891	.73
[EC2] Intensity of collaboration in NPD with competitors.	.794		
[EC3] Intensity of collaboration in NPD with suppliers.	.769		
[EC4] Intensity of collaboration in NPD with public institutions.	.755		
[EC5] Intensity of collaboration in NPD with other market actors.	.703		

Table 20. Intensity of external collaboration construct validity.

I Inspection of the correlation matrix revealed that all coefficients were .4 or above indicating that an Oblimin rotation was the most suitable. The suitability of PCA was assessed prior to analysis using the KMO and Bartlett's test measures. KMO was .675

thereby exceeding the recommended minimum of 0.6. Bartlett's test of sphericity was statistically significant for the construct ($p < .000$), indicating that the data was suitable for PCA. All factor loadings were above the recommended .70, and both the Cronbach's Alpha score and AVE value exceeded their cutoff points of .70 and .50 respectively. Only a single eigenvalue exceeded the cutoff point of 1.0 with 2.289 supporting the use of the items in a single construct. The results of this analysis confirm the validity of the intensity of external collaboration construct.

4.5.3. Market Information Generation

Market Information Generation	Factor loadings	Cronbach's Alpha	Average Variance Extracted
[IG1] We define a set of criteria for which market actors should be examined.	.828	.875	.82
[IG2] Based on thorough analysis insightful market actors are selected for further interview.	.827		
[IG3] We collect market information through methods which ensure a comprehensive picture of the market.	.822		

Table 21. Market information generation construct validity.

Inspection of the correlation matrix revealed that all coefficients for all three items were .6 or above indicating that an Oblimin rotation was the most suitable. KMO was .717. Bartlett's test of sphericity was statistically significant for the construct ($p < .000$), indicating that the data was suitable for PCA. All factor loadings were above the recommended .70 and inspection of eigenvalues (3.167) confirm the use of a single factor. Both the Cronbach's Alpha score and AVE value exceeded their cutoff points of .70 and .50 respectively. The results of this analysis confirm the validity of the Market information generation construct.

4.5.4. Market Information Dissemination

Inspection of the correlation matrix revealed that all coefficients were .4 or above indi-

cating that an Oblimin rotation was the most suitable. KMO was .707 and Bartlett's test of sphericity was statistically significant for the construct ($p < .000$), indicating that the data was suitable for PCA. All factor loadings were above the recommended .70, and both the Cronbach's Alpha score and AVE value exceeded their cutoff points of .70 and .50 respectively. A single eigenvalue over the 1.0 cutoff (2.291) support the retention of a single component thereby confirming the validity of the Market information dissemination construct.

Market Information Dissemination	Factor Loadings	Cronbach's Alpha	Average Variance Extracted
[ID1] We regularly share ideas and concerns from customers.	.857	.825	.74
[ID2] We have effective systems for information sharing in the organization.	.778		
[ID3] A large part of the informal communication are about our competitors strategies.	.772		
[ID4] We hold regular meetings to discuss market trends	.714		

Table 22. Market information dissemination construct validity.

The literature review presented in chapter 2 and the operationalization of constructs presented previously in this paper indicated that market information generation and dissemination constructs are part of the same overall conceptual framework of information processing and are therefore operationalized as two, first order constructs. However, to check if these constructs are significantly different from on another a PCA analysis was used with all the items from both constructs to verify their factor loadings and under how many components they load. As expected the KMO .745 and Bartlett's test of sphericity was statistically significant for the construct ($p < .000$), confirming the suitability of the PCA. The results indicate a weak positive correlation between the two factors but the items loaded significantly on two components supporting the use of market

information processing and dissemination as two separate constructs.

4.5.5. Market Innovativeness

Market Innovativeness	Factor Loadings	Cronbach's Alpha	Average Variance Extracted
[MI1] Our new products/services provides new value from customers thats not been possible before.	.878	.881	.66
[MI2] Our new products/services has created a whole new market.	.853		
[MI3] Our new products/services has significantly changed the market mechanisms.	.850		
[MI4] Our new products/services has significantly changed the value chain in our industry.	.799		
[MI5] Our new products/services has attracted new customers not previously served by our industry.	.761		
[MI6] Our new products/services can be characterized as very new to the market.	.607		

Table 23. Market innovativeness construct validity.

Like the confirmatory PCA used in the previous constructs, an Oblimin rotation was used because all the items correlated above the recommended .3 threshold for the varimax rotation. All but one-factor loadings exceeded the .70 cutoff, and only a single eigenvalue was above 1.000, at 3.807 indicating that the items could all be reduced to a single construct. Bartlett's test was significant ($p < .000$), and KMO was calculated to .858 confirming the suitability of the PCA. Both Cronbach's Alpha and AVE are within accepted parameters, which partially confirms the validity of the Market Innovativeness construct used in this study. However, the last item was dropped from the construct because of the relatively small factor loadings.

Market Innovativeness	Factor Loadings	Cronbach's Alpha	Average Variance Extracted
[MI1] Our new products/services provides new value from customers thats not been possible before.	.878	.881	.66
[MI2] Our new products/services has created a whole new market.	.853		
[MI3] Our new products/services has significantly changed the market mechanisms.	.850		
[MI4] Our new products/services has significantly changed the value chain in our industry.	.799		
[MI5] Our new products/services has attracted new customers not previously served by our industry.	.761		
~~[MI6] Our new products/services can be characterized as very new to the market.~~	.607		

Table 24. Market innovativeness revisited.

4.5.6. Discriminate validity of constructs

Discriminate also referred to as divergent, validity is evidence that a measure is not unjustifiably related to other similar, yet distinct, constructs. Correlation coefficients between measures for a construct and measures of conceptually different constructs are usually presented as confirmation of discriminant validity. If the correlation coefficients are high, this shows a lack of discriminant validity or weak discriminant validity. This, however, depends on the theoretical relationship and the magnitude of the coefficient. However, if the correlations are low to moderate, this indicates that the measure has discriminant validity. The items-to-construct correlations marked in bold are those that belong to the corresponding constructs and are therefore expected to display significant correlations.

Item	NPD portfolio performance	Intensity of External collaboration	Information generation	information dissemination	Market Innovativeness
Perf1	**.497**	.162	,272	.130	.443
Perf2	**.599**	.124	.268	.311	.377
Perf3	**.485**	.196	.216	.300	.374
EC1	.064	**.596**	.276	.468	.287
EC2	.094	**.617**	.179	.184	.230
EC3	-.019	**.662**	.129	.227	.046
EC4	.025	**.694**	.227	.213	.368
EC5	-.106	**.753**	.138	.235	.258
IG1	.202	.173	**.815**	.174	.160
IG2	.241	.300	**.823**	.327	.254
IG3	.218	.257	**.814**	.295	.296
ID1	.165	.453	.319	**.823**	.348
ID2	.135	.202	.376	**.800**	.170
ID3	-.009	.305	.140	**.799**	.129
ID4	.225	.284	.465	**.723**	.479
MI1	.113	.170	.264	.284	**.638**
MI2	.160	.255	.253	.147	**.824**
MI3	.223	.239	.230	.192	**.837**
MI4	.183	.294	.243	.244	**.787**
MI5	.131	353	.117	.270	**.769**

Table 25. Item-to-construct correlation matrix.

The item-to-construct correlations for the items and constructs used in this study indicate that the items correlate with their intended constructs and more importantly for this test, not significantly with other constructs used in the study. The one item from the market innovativeness constructs that was found to have insufficient factor loadings, and, therefore, little reliability was excluded from the discriminate validity test. Since all items reveal relatively high correlations with their corresponding constructs, it is sufficiently supported that these constructs have discriminate validity.

The final step in checking for discriminate validity is applying the Fornell-Larcker criterion. The criterion predicates that, for adequate discriminate validity, the square root of the average variance extracted has to be large than the correlation coefficients with the other constructs. In Table 25 the properties of the Fornell-Larcker criterion is presented. The value on the diagonal and in bold is the square root of the AVE. The table reveals that the square root of the AVE is always higher than the correlation coefficients with other constructs indicating the presence of adequate discriminate validity.

	1	2	3	4	5
1.NPD portfolio performance	**.81**				
2.Intensity of external collaboration	.129*	**.85**			
3.Market information generation	.272**	.308**	**.90**		
4.Market information dissemination	.130*	.346**	.358**	**.86**	
5.Market innovativeness	.216**	.362**	.278**	.289**	**.81**

**. Correlation is significant at the 0.01 level (2-tailed;*. Correlation is significant at the 0.05 level (2-tailed).

Table 26. Fornell-Larcker Criterion.

4.6. Construct Collinearity

Collinearity denotes the degree of linear dependency between more than two indicators. Several problems are associated with collinearity. First, with increasing collinearity the contributions of the individual independent variables to the explanation of the variance of the dependent variable become difficult to identify[246]. Second, collinearity can impact the estimation of regression coefficients and their statistical significance. At the extreme, with perfect collinearity, the estimation of coefficients via least squares method becomes impossible[247]. Third, One of the features of multicollinearity is that the standard errors of the affected coefficients have a tendency to be large. The best regres-

246 Woolridge (2009).

247 Hair et al. (2010).

sion models are those in which the predictor variables each correlate highly with the dependent variable. However, they should correlate at most only minimally with each other. A model with these characteristics is often called "low noise" and will be statistically robust. In other words, the model will predict reliably across many samples of variable sets drawn from the same statistical population.

4.6.1. Correlations

Correlation is used to describe the strength and direction of the linear relationship between two variables. This is the simplest method to reveal collinearity. The correlation matrix is calculated for all items of a certain construct. Correlations of over 0.9 are clear indications for collinearity. For correlations beyond 0.7 the affected items should be verified in respect of the content. In this study the relationship between the dependent variable (NPD portfolio performance), the independent variables (intensity of external collaboration, information processing constructs and market innovativeness) is investigated along with the control variables using Pearson product-moment correlation.

	1	2	3	4	5	6	7	8	9	10	11
1.NPD portfolio performance	—										
2.Intensity of external collaboration	-.129*	—									
3.Market information generation	.272**	.308**	—								
4.Market information dissemination	.130*	.346**	.358**	—							
5.Market innovativeness	.216**	.362**	.278**	.289**	—						
6.Firm size	.094	-.109	.214**	-.139*	-.010	—					
7.Turbulence	.128*	.112	.074	-.008	.293**	-.080	—				
8.B2B_Focus	.165*	-.013	.138*	-.177*	.319**	.115	.117	—			
9.B2C_Focus	-.117	.179**	-.113	.172**	-.210**	-.112	-.060	-.714**	—		
10.Formalization	.054	.032	.398**	.093	.054	.364**	-.082	-.036	-.079	—	
11.Technical innovativeness	.133*	.230**	.303**	.396**	.560**	-.010	.278**	-.021	.021	.246**	—

**. Correlation is significant at the 0.01 level (2-tailed;*. Correlation is significant at the 0.05 level (2-tailed).

Table 27. Pearson's Correlations.

Based on the literature review it reasonable to expect that the intensity of the firms external collaboration in NPD was positively, and significantly correlated with NPD portfolio performance. However, the relationship was found to be significant but negative, indicating that when the intensity of external collaboration increases, NPD portfolio performance decreases, r= -.129, n= 241, p= .05. Moreover, Intensity of external collaboration does significant and positively correlate with the firms Business-to-consumer (B2C) focus, r= .179, n= 239, p= .006. This is at least partially supported by the literature, which found strong relationships between firms focus on the consumer and its ability to benefit from external collaboration[248]. An increase in one is observed along with an increase in the other. Furthermore, a positive correlation was also found between both innovativeness factors. This is not surprising for the technological innovativeness control. *Zhou, Yim, & Tse (2005)*, found that customers was beneficial when trying to develop something technologically new, but had a harder time with highly market innovative products. This indicates that we can expect an increase in external collaboration to benefit market innovativeness up to a certain point before dropping off.

Market information generation on the other hand was found to be significantly correlated with both NPD portfolio performance, r= .272, n= 264, p= .000, and market innovativeness, r= .278, n= 270, p= .000, as was expected since the ability to generate market information has been linked directly to performance measures[249]. Likewise, market information generation has also been associated with market innovativeness[250]. As the newness to market increases so does the uncertainty associated with the NPD project, hence the need for greater information processing. However, the correlations was found

---

248 Han, J., Kim, N., & Srivastava, R. (1998). Bharadwaj, N., Nevin, J. R., & Wallman, J. P. (2012).

249 e.g., Slater and Narver (2000); Bergh (1998).

250 Zhou, Yim, and Tse (2005); Cillo, De Luca, and Troilo (2010).

to be small[251]. As expected the relationship between information generation and information dissemination was found to be significantly but only moderately correlated, r= .358, n= 271, p= .000. This is in line with previous literature, which suggested that the two construct are part of the same overall conceptual dimension of information processing. It is therefore expected to find indicators of a correlation between the two. Furthermore, the relationship between information dissemination and market innovativeness also supported by the correlation, r= .289, n= 270, p= .000. Like the information generation variable a correlation between dissemination and market innovativeness can in all likelihood be explained by the inherent uncertainty associated with an increase in market innovativeness leading to an increased need for information dissemination.

Among the control variables, only Turbulence and Technological innovativeness had a small and positive correlation with NPD portfolio performance. The relationship between turbulence and NPD portfolio performance r= .128, n= 259, p= .039 indicates that when one increases so does the other. Based on the literature review one explanation for this could be that higher levels of NPD portfolio performance are associated with greater levels of market and technological innovativeness thereby increasing the overall turbulence the firms environment. The small positive correlation between NPD portfolio performance and technological innovativeness r= .123, n= 264, p= .031 and the medium effect market innovativeness on NPD portfolio performance described above lends support to this line of reasoning.

The relationship between the two customer focus variable, B2C and B2B are, as expected, highly correlated and negative r= -.714, n= 212, p= .000. This indicates that there is a relationship between the two and when one goes up the other goes down, lending support to the assumption that the firms will tend to focus on either the consumer or business market. Furthermore, the B2B variable was positively and significantly associated with NPD portfolio performance r= .165 n= 207, p= .017. There was found no signifi-

[251] Pallant (2010).

cant relationship between B2C focus and NPD portfolio performance.

Finally, firm size and degree of formalization was tested but no relationship with NPD portfolio performance as found. However, as expected both of these variables were highly correlated in the positive direction, r= .364, n= 258, p= .000. the B2B control variable was also positively correlated with information generation, r= .138, n= 209, p= .047. based on the literature a plausible explanation for this correlation might be that when the need for market information generation increases so does the need for formalized structures. More specifically, processes to handle the greater flow of information .
While the correlation matrix approach does provide strong indicators for collinearity problems it can only identify linear dependencies between two variables but not between three or more. Hence, additional methods are required.

4.6.2. Variance inflation factor and condition index

In multiple regression, the variance inflation factor (VIF) is used as an indicator of multicollinearity. In calculation terms, it is defined as the reciprocal of tolerance: 1 / (1 - R2). All other things being equal, researchers aspire to lower levels of VIF because higher levels of VIF are known to impact adversely the results associated with multiple regression analysis. The utility of VIF is that VIF specifically indicates the magnitude of the inflation in the standard errors associated with a particular beta weight that is due to multicollinearity. Several different recommendations for acceptable levels of VIF can be found in the literature. Perhaps most commonly, a value of 10 has been recommended as the maximum level of VIF[252]. The VIF recommendation of 10 corresponds to the tolerance recommendation of .10. However, a VIF value of 5[253] can be found in the literature as the recommended maximum. It would, therefore, appear that researchers can use which ever criterion they wish to help serve their purposes.

Tushman and Nadler (1978).

252 e.g., Hair, Anderson, Tatham, and Black (1995); Kennedy (1992); Marquardt (1970); Neter, Wasserman, and Kutner (1989)

253 e.g., Rogerson, 2001.

To derive the tolerance and VIF measures, multiple regressions are calculated where each indicator is explained through all other items. The tolerance measure is defined as the portion of the variance which cannot be explained by the other indicators. It is the difference between one and the coefficient of determination (R). VIF is defined as the reciprocal value of tolerance. For perfect linear independency, tolerance reaches its maximal value of one and VIF its minimal value of one. VIF should not exceed a threshold value of 10, which corresponds to a multicollinearity of 0.95. However, for each construct the acceptable level of collinearity should be separately defined driven by content considerations. The tolerance/VIF approach does, however, not provide any information about the number of linear dependencies among the involved constructs. To address the weakness of the tolerance/VIF approach the condition index is used. The condition index is a measure of near-dependencies. A high condition index indicates the existence of near-dependencies. For the condition index *Hair et al., (2010)* suggests a threshold value 30.

VARIABLE	VARIANCE INFLATION FACTOR	CONDITION INDEX
Intensity of External Collaboration	1.416	11.654
Market Information Generation	1.770	14.544
Market Information Dissemination	1.672	16.021
Market Innovativeness	2.165	18.691
FIRM SIZE	1.398	8.371
GEOGRAPHY	3.442	4.158
FORMALIZATION	1.550	25.508
TURBULENCE	1.201	10.175
B2C	3.168	23.186
B2B	2.451	21.371
TECHNOLOGICAL INNOVATIVENESS	1.879	28,327

Table 28. Variance inflation factor and condition index as indicator for multicolloneariy.

4.7. Common Method Bias

Since this study relies on information provided by multiple respondents with dependent and independent variables measured by different respondents, the issue of common method bias has to some extent been addressed by the study design. However, with a cross-sectional research design, common method variance, meaning variance that is attributed to the measurement method rather than the constructs of interest, can cause systematic measurement error. Further biasing the approximation of the true relationship between theoretical constructs. Method variance can either inflate or deflate the observed relationships between constructs, thus leading to both Type I and Type II errors[254]. Confirmatory factor analysis and Harman's one-factor test, post hoc statistical tests, were conducted to test for the presence of common method effects. All items comprising the four independent variables and the dependent variable were forced to load on one factor to examine the fit of the confirmatory factor analysis model. If a substantial amount of common method variance is present, either a) a single factor will emerge from the factor analysis, or b) one general factor will account for the majority of the covariance among the variables[255]. Hence, if the common method variance is largely responsible for the relationship between the variables, the one-factor confirmatory factor analysis model should fit the data well.

The unrotated principal component factor analysis with varimax rotation revealed the presence of five distinct factors with an eigenvalue greater than 1.0, rather than a single factor. The five factors together accounted for 70.7 percent of the total variance; the first, and largest factor did not account for a majority of the variance (29%). Thus, no general factor is apparent. While the results of these analyzes do not preclude the possibility of common method bias, they do suggest that common method bias is not of great concern and thus is unlikely to confound the interpretations of results.

---

254 Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Podsakoff & Organ, 1986.

255 Hair et al., 2010.

4.8. Summary of empirical study

Based on the literature review and hypotheses development all measures used in this study was adapted from previously used and validated scales. The study design and sample was created according to conventional norms. All measures were found to be both conceptually sound and statistically valid within the parameters of item reliability, convergent validity, and discriminate validity. All items, except one which was dropped, loaded significantly on their respective constructs and Cronbach's alpha along with AVE confirmed the reliability of these constructs. The item-to-construct correlations confirmed that no items loaded inappropriately on other constructs than their intended.

The correlations reveal no significant correlations with values high enough to indicate the presence of a collinearity problem. This is confirmed by VIF and condition index scores. With all VIF values for the variables employed in this study falling between 1.146 and 3.442 the variance inflation are well below the 10-point threshold, and even the 5 point, set in the literature. Likewise, all the variables had values lower than 30 on their condition index.

The tests indicate that neither item reliability, multicollinearity or common method bias is an issue for the hypotheses test with regression analysis in the next part.

Chapter 5 - Results

Regression analysis was applied because the intent of the study is to understand the relationship among different variables (see Chapter 6). As a regression model is a well-known approach when analyzing the relationship between a defined dependent variable and chosen independent variables. A challenge when using regression analysis is the choice of variables that fulfill the research purpose [256].

The three-way interactions which often thought of as a relationship between a variable X and dependent variable Y, moderated by variables Z and W. This interaction was done by running the multiple hierarchical regression analysis, including all three independent variables, all three pairs of two-way interaction terms, and the three-way interaction term. *Woolridge (2009)* suggests that all the independent variable are standardized before calculation of the interaction, which was done. Both the two-way and three-way interaction term should be significant in the regression equation for the interaction to be interpretable.

5.1. Regression assumptions

In hierarchical multiple regression, the independent constructs are entered into the analysis in sequence. The sequence being specified by the researcher. The hierarchical structure allows the regression equation to calculate what the independent adds to the prediction of the dependent variable after the previous variables have been controlled for. However, as a statistical technique hierarchical multiple regression demands a series of assumption, which if violated severely impacts the results of the analysis. The issue at stake here is generalizability. Following *Tabachnick and Fidells (2007)* formula for determining the sample size requirement for a reliable regression equation ($N > 50 + 8m$, where m is the number of independent variables used in the model) I conclude that 82 cases are the minimum number I can use in this study. A requirement that is easily

256 See Hair et al. (2010).

meet with a sample of over 240 cases. However, more cases are needed if the dependent variable is skewed, the inspection of the *Normal Q-Q Plot* and the *Detrended Normal Q-Q Plots* indicate that the dependent variable is normally distributed. Furthermore, based on the test run in the previous section collinearity problems can be ruled out. Inspection of the residuals scatterplot revealed no violation of the normality, linearity and homoscedasticity assumptions.

5.2. Verification of regression equation

This first test deals with the entire regression function. It investigates how good the dependent variable is explained by the independent variable(s). Coefficients of determination and F-test are typically applied:

First, Coefficient of Determination, or R^2, measures the goodness of fit between the overall regression function and the empirical data. R2 is defined as the ratio of the explained variance divided by the total variance. Hence, a value of 0.4 means that 40% of the variance is based on factors included in the regression function and 60% on factors not accounted for in the regression model. The standard coefficient of determination, adjusted R^2 is also reported. Adjusted R^2 also takes into account the number of explanatory variables. Therefore, the adjusted R^2 is always smaller than the standard one. Second, The F-test addresses the question of model validity for the entire population and not only for the sample. Besides the variance, it also considers sample size.

5.3. Results

When discussing how the intensity of external collaboration impacts NPD portfolio performance moderation has a profound impact on the debate and conceptualization of the phenomenon. With the perspective from contingency theory in mind, this study assumes that the relationship between external collaboration in NPD and NPD performance is heavily influenced by the organizational and environmental context under which the NPD process takes place. To measure the contingency effect of market innovativeness, a moderation perspective is adopted. The moderation approach assumes that the impact of

an independent variable, e.i. The intensity of external collaboration has on the dependent variable, e.i. NPD portfolio performance is conditional upon the level of a third variable, called the moderator. The fit between the independent variable and the moderator is the primary determinant of the dependent variable[257]. For easy reference, the list of hypotheses is included.

- *Hypothesis 1:* There is a positive direct relationship between the intensity (breath and depth) of the firm's external collaboration and NPD portfolio performance.
- *Hypothesis 2a:* There is a positive direct relationship between the intensity of the firms' market information generation and its NPD portfolio performance.
- *Hypothesis 2b:* There is a positive direct relationship between the intensity of the firms' market information dissemination and its NPD portfolio performance.
- *Hypothesis 2c:* Combining market information generation and dissemination further enhance NPD portfolio performance.
- *Hypothesis 3a:* Combining intensity of collaboration and market information generation further increases NPD portfolio performance.
- *Hypothesis 3b:* Combining intensity of collaboration and market information dissemination further increases NPD portfolio performance.
- *Hypothesis 4a:* A firms' ability to benefit from external collaboration in the NPD process is weakened when the new product development program has a higher degree of market innovativeness.
- *Hypothesis 4b:* A firms' ability to benefit from market information generation in the NPD process is weakened when the new product development program has a higher degree of market innovativeness.
- *Hypothesis 4c:* A firms' ability to benefit from information dissemination in NPD is weakened when the new product development program has a higher degree of market innovativeness.
- *Hypothesis 5a:* The combined impact of external collaboration and market informa-

257 See e.g. Hair et al. (2010)

tion generation on NPD performance becomes weaker when the NPD program has a higher degree of market innovativeness.

- *Hypothesis 5b:* The combined impact of external collaboration and market information dissemination on NPD performance becomes weaker when the NPD program has a higher degree of market innovativeness.

The hypotheses were tested with a hierarchical ordinary least squares regression. Table 28, model 1 shows the regression of NPD performance on the control variables; Model 2 includes the direct hypothesized effects of market information generation, information dissemination, external collaboration, and Market innovativeness; and in model 3, the moderation effect of market information generation with dissemination was tested along with the effect of both information processing activities with external collaboration. Therefore, Model 4, includes market information processing activities and external collaboration with market innovativeness as a moderator. Finally, in model 5, the three-way interaction effect of market information generation, external collaboration and program innovativeness are tested, along with information dissemination, external collaboration and program innovativeness. All moderation effects were tested using standardized variables. As the model fit is greatest for the fifth model with a adjusted R^2 of 19.9%. This is a statically significant contribution, as indicated by the significant change in F value, Hence, these results are reported.

Dependent variable: NPD Portfolio Performance	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Control Variables					
Country (1: Austria)	**-.306 (.152)****	**-.289 (.163)***	**-.283 (.164)***	-.146 (.163)	-.132 (.159)
Firm size	.014 (.050)	.019 (.050)	.018 (.050)	.028 (.048)	.029 (.047)
Level of Formalization	-.012 (.044)	-.045 (.047)	-.042 (.047)	-.037 (.046)	-.025 (.045)
Turbulence	**.129 (.065)****	.087 (.068)	.079 (.068)	.063 (.066)	.039 (.065)
Technological Innovativeness	-.085(.075)	-.077 (.074)	-.067 (.076)	-.049 (.074)	-.024 (.073)
Level of Customer orientation					
B2C Focus	.023 (.040)	.024 (.041)	.031 (.041)	.064 (.041)	.059 (.040)
B2B Focus	.043 (.055)	.052 (.056)	.051 (.056)	.048 (.055)	.045 (.053)
Independent Variables					
Market Innovativeness		.070 (.081)	.065 (.081)	**.157 (.082)****	**.229 (.084)*****
External Collaboration		**-.177 (.088)****	**-.181 (.096)***	**-.213 (-094)****	**-.199 (.092)****
Market Information generation		.121 (.083)	**.133 (.085)***	.090 (.083)	**.151 (.083)***
Market Information Dissemination		**.143 (.084)***	.141 (.089)	**.149 (.086)***	**.168 (.086)****
Two-way Interactions					
Market information generation x Market information dissemination			.002 (.045)	.019 (.045)	-.001 (.044)
Market information generation x External Collaboration			.078 (.047)	**.092 (.048)****	**.133 (.049)*****
Market information dissemination x External collaboration			-.010 (.045)	.016 (.044)	.007 (.045)
Market information generation x Market Innovativeness				.067 (.050)	.073 (.048)
Market information dissemination x Market Innovativeness				**-.176 (.046)*****	**-.159 (.050)*****
External Collaboration x Market Innovativeness				-.007 (.040)	-.031 (.044)
Three-way Interactions					
Market information generation x External collaboration x Market innovativeness					**-.130 (.042)*****
Information dissemination x External collaboration x Innovativeness					.024 (.044)
F	2.55	2.80	2.41	2.85	3.60
ΔF	2.55**	3.01***	1.09***	4.20***	7.77***
R^2	.078	.136	.152	.210	.276
Adjusted R^2	.047	.087	.089	.136	.199
ΔR^2	.78	.58	.016	.058	.066

Unstandardized beta coefficients; Standard errors. NPD = New product development. N=246

* $p < .1$; ** $p < .05$; *** $p < .01$

Table 29. Hierarchical Multiple Regression.

Market innovativeness, while not in and of itself a hypothesized effect because of it role as a moderator in this study, had a significant and positive impact on NPD performance ($\beta = .157$, $p < 0.05$). The positive relationship between market innovativeness and NPD performance is expected and in line with previous research, which found that products with a high degree of market innovativeness enabled the firm to meet evolving customer needs in high-velocity markets[258].

In the fifth model, none of the selected control variables had any significant effect when taking the other variables into account, giving support to the underlying model of this of this study.

5.3.1. The external collaboration - NPD portfolio performance relationship

The first independent — dependent variable relationship tested was the impact of intensity of external collaboration on NPD portfolio performance. However, contrary to my expectations from the literature review this relationship was found to have a significant but negative impact on NPD portfolio performance ($\beta = -.199$, $p < 0.05$) thereby producing no support for Hypothesis 1. The majority of the current literature on the use of external collaborators in NPD clearly links input from external sources of innovation with higher NPD performance[259]. However, in this study the object of interest is the intensity of external collaborators, and the results, while counterintuitive are explained by the resource requirements need for dealing with multiple collaborators at the same time. The negative result observed here is therefore likely a reflection of the time and coordination costs that are sunk into establishing, maintaining and coordinating the collaboration. The negative impact is in all likelihood further exasperated by the variety of external sources. Whose contribution to the NPD process is also likely to differ significantly further increasing the cost of recombining the information from the different sources into a valuable input to NPD.

---

258 Slater, Mohr, & Sengupta, 2013.

259 See Von Hippel (2009); Faems et al. (2010); Rothaermel and Alexandre (2009).

5.3.2. The information processing - NPD portfolio performance relationship

From the literature the two information processing variables were both expected to be positively related to NPD portfolio performance[260]. Market information-processing constructs are, therefore, added to the model. Market information generation did as expected show a direct positive impact on NPD portfolio performance as expected ($\beta = .121$, $p < .1$) providing support for Hypothesis 2a. Likewise, information dissemination was found to have a significant positive impact on NPD performance ($\beta = .168$, $p < .05$) providing support for Hypothesis 2b. The ability to generate and disseminate market information has previous been linked to NPD performance[261]. The literature on information processing suggests that market information generation and dissemination are two distinct activities that contribute to NPD[262]. The separation of the two variables is supported by the factor analysis[263], and the results presented here supports the notion that both impact NPD performance significant- and positively. Hence, having established methods and criteria for selecting, collecting and disseminating through formal and informal means are important drivers of NPD portfolio performance.

Previous research[264] showed a clear positive relationship between the interaction of market information generation and dissemination on NPD portfolio performance. The combined effect of market information generation and dissemination was tested. To test for two-way interactions[265], it is recommended that the independent variable and moderator are standardized before calculation of the independent variables used in the interaction. However, for the interaction between market information generation and dissemination on NPD portfolio performance there is no significant result in the model for this

---

260 Sinkula (1994).

261 See Hunt and Morgan (1995).

262 See Day, G. S. (1994).

263 See the Item reliability and validity section in chapter 4.

264 See Hultink et al. (2011).

265 Conceptualized as the relationship between an independent variable and dependent variable, moderated by a third variable.

interaction ($p > 0.05$) and hypothesis 2c is therefore not supported.

5.3.3. The Interaction of external collaboration and information processing on NPD Portfolio performance

Next, market information generation was tested with external collaboration on NPD portfolio performance providing positive and significant support for Hypothesis 3a ($\beta = .152$, $p < 0.01$). The results show that having the ability to follow the activities of market actors, be it customer, competitors or other organization, has a positive impact on NPD activities. The ability to identify and generate information from the right collaborators, therefore, becomes an important aspect of NPD projects. However, the interaction between market information dissemination and external collaboration was not found to have a significant impact on NPD portfolio performance ($p > 0.05$), providing no support for Hypothesis 3b. Since market information dissemination in itself appears to impact positively NPD portfolio performance it seems there is a barrier between external collaborators and the firm. These barriers make it difficult for the firm to spread the information that it generates across different groups and units within.

The results for Hypotheses Hypothesis 3a and Hypothesis 3b tells us that information from external collaborators appears to contribute positively to the NPD performance when handled and used by the members of the NPD team in direct contact with the external sources. However, trying to disseminate this information to the rest of the firm has no discernible effect.

5.3.3.1. Supporting analysis

To strengthen the results of the regression analysis regarding the moderating effect of market information generation and intensity of external collaboration on NPD portfolio performance (Hypothesis 3a). The interaction is analyzed further using post hoc probing of the simple slopes[266]. Only significant interactions from the regression equation are interpretable using simple slopes, so only Hypotheses 3a is tested. This analysis offers both support and clarification for the hypothesized relationship.

---

[266] See Aiken and West (1991).

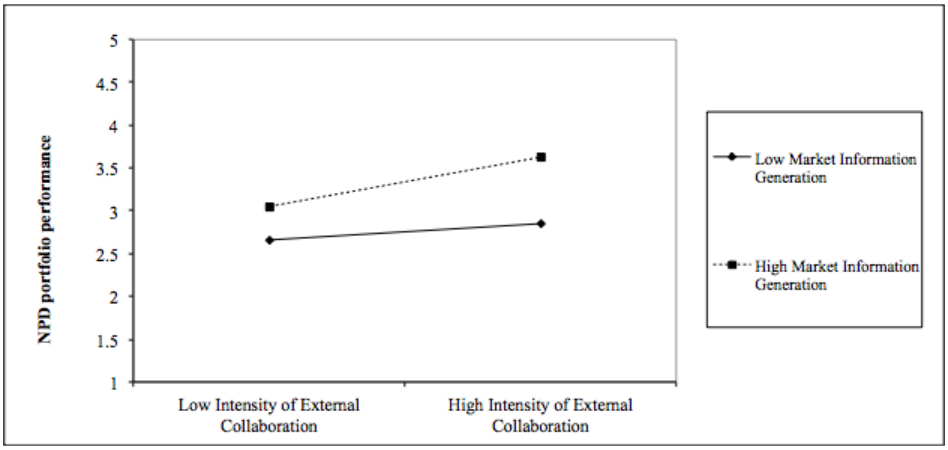


Figure 16. Simple slopes for Intensity of external collaboration x market information generation on NPD portfolio performance.

Figure 16 examines the simple slopes for the two-way interaction effect hypothesized in 3a, using only high and low values for the two independent variables. The left side shows the standardized NPD portfolio performance values for low intensity of external collaboration levels (one standard deviation .56 below the mean of 2.60, i.e., 2.04). The right side shows the level of high intensity of external collaboration (one standard deviation above the mean, i.e. 3.16,). The solid line indicates a low market information generation capabilities for the firm, and the dotted line high market information generation capability.

Figure 16 shows that if the firm has a low capability for market information generation (solid black line with diamond ends), collaborating with external sources is problematic no matter the intensity of the collaboration (both high and low values). However, if the firms market information generation capability is high (dotted line with square ends) the impact of using external collaborators is stable across high and low levels of intensity of external collaboration. Furthermore, the greatest impact on NPD portfolio performance is achieved with both high intensity of external collaboration and a strong capability for market information generation (right side, figure 16). This indicates that market information generation is indeed an important capability for firm engaged in collaboration with many external sources. This confirms the support for hypothesis 3a.

5.3.4. The moderating effect of the market innovativeness contingency

The next step in the analysis tested the effect of market innovativeness on the relationship between the intensity of external collaboration, market information processing constructs, and NPD portfolio performance.

First, The interaction between external collaboration and market innovativeness was tested. It did not have any significance ($p > .05$) providing no support for Hypothesis 4a. Second, the interaction effects between market information generation and market innovativeness were tested, which was not significant ($p > 0.05$), providing no support for Hypothesis 4b. Third, the effect of information dissemination and innovativeness proved to be significant and negative ($\beta = -.159$, $p < 0.01$), providing partial support for Hypothesis 4c. The negative relationship indicates that disseminating information regarding a project where market uncertain is a factor is a significant challenge for the NPD team. The effort of disseminating appears to demand more resource than the actual value of the tasks involved is worth in terms of NPD portfolio performance.

5.3.4.1. Supporting analysis

To examine the significant interaction between market information dissemination and market innovativeness on NPD portfolio performance, the simple slopes are calculated (see figure 17).

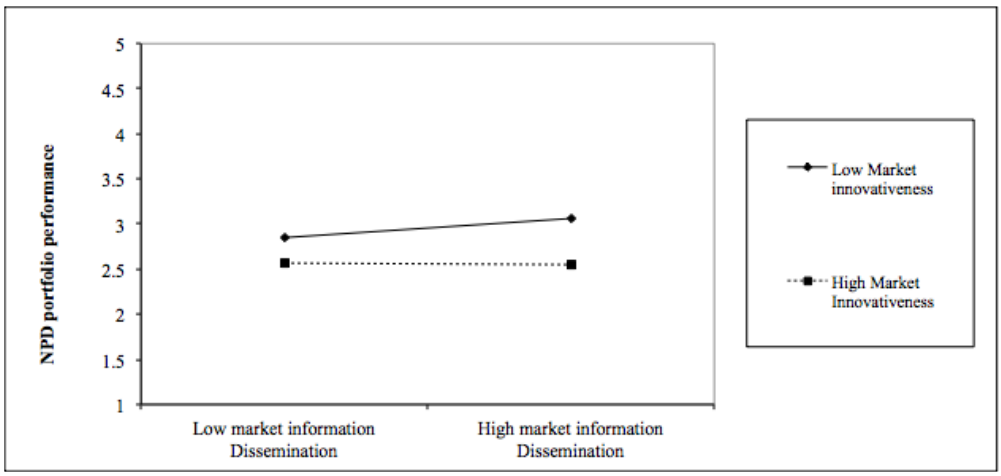


Figure 17. Simple slopes for market information dissemination x market innovativenss on NPD portfolio performance.

The left side of the figure shows the standardized NPD portfolio performance values for low market information dissemination capabilities within the firm (one standard deviation .65 below the mean of 3.33, i.e., 2.68). The right side shows the standardized NPD portfolio performance values for high levels of market information dissemination capability (one standard deviation above the mean, i.e., 3.98). The solid line indicates low levels of market innovativeness, i.e., incremental innovations while the dotted line represents high levels of market innovativeness, i.e., radical innovations.

The results indicate that for NPD projects with high levels of market innovativeness trying to disseminate information is overall detrimental to NPD performance (see dotted line with solid black squares) However, if the NPD project has lower level of innovativeness, i.e., incremental innovations, there appears to be a slight performance benefit to be had if the firm has a high degree of formal and informal structures in place for disseminating market information (see right side of figure. 1). It, therefore, seems that the firm should be apprehensive about throwing resources at dissemination of market information as this has a direct negative impact on NPD portfolio performance. However, if the firm has strong formal and informal capabilities for handling the dissemination of market information there appears to be no significant difference in impact between incremental and radical NPD projects. The results could very well be due to two factors, which could be present simultaneously or separately in the firm conducting the NPD process. The negative result when moderating with NPD could very well be due to either a ‘not invented here’ type reaction, where the information is invalidated due to resistance. It could also be the case that the information is not of a format that the firm is accustomed, thereby increasing the cost of disseminating it.

5.3.5. The three-way interaction effect for all independent variables on NPD portfolio performance

Finally, the three-way interaction effects were tested. The relationship between market information generation, external collaboration and market innovativeness proved to be

significant but negative (β = -.222, $p < 0.05$) providing support for Hypothesis 5a. Likewise, the null hypothesis was not disapproved for the relationship between information dissemination, external collaboration, and innovativeness ($p > 0.05$) providing no support for Hypothesis 5b. The overall picture, therefore, tells us that external collaboration and market information generation has a positive impact on NPD portfolio performance. The firm's ability to generate market information can, therefore, be said to moderate the otherwise negative effect of bringing hard to process information from external collaborators into the NPD process positively. However, this effect disappears when the contingency of market innovativeness is brought in as an additional moderating effect. The added level of uncertainty brought on by market innovativeness makes relying on external collaborators or market information generation less effective. In other word, the results tell us that the firm's internal ability to generate market information is an important success factor for incremental innovation. However, better methods are required if multiple external partners are involved and the project has a high degree of innovativeness

5.3.5.1. Supporting Analyses

To give a more complete image of the interaction proposed and supported by hypothesis H5a the relationship between market information generation, external collaboration, and market innovativeness, as they relate to NPD program performance, is further analyzed using post hoc probing of the simple slopes. This analysis clarifies the results from the hierarchical linear regression analysis

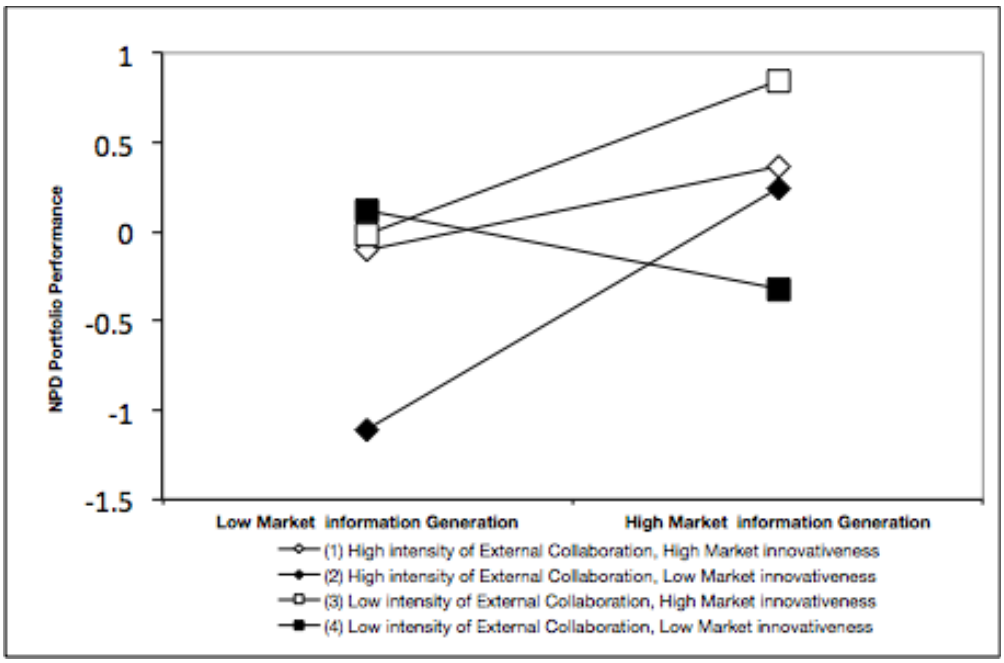


figure 18. Simple slope for intensity of external collaboration x market information generation x market innovativeness on NPD portfolio performance.

Figure 18 presents the simple slopes for the three-way interaction effect between external collaboration, market innovativeness and market information generation on NPD portfolio performance with only low and high values shown for the three independent variables. The left side shows the standardized NPD performance values for low levels of market information generation (one standard deviation .72 below the mean of 2.81 i.e. 2.09. The right-hand side shows the level for high levels of innovativeness (one standard deviation above the mean, i.e., 3.53). The diamond squares indicate a high level of external collaboration while squares indicate a low level of external collaboration. The white and black filling indicates high and low levels of market innovativeness.

If market information generation is low as seen on the left side of figure 18, NDP portfolio performance does not significantly benefit from any combination of internal information processing capabilities in conjunction with external collaboration. This lack of benefit holds true in situations with either high and low levels of market innovativeness. In situations with high levels of market information generation within the firm,

external collaboration can contribute to overall NPD portfolio performance. However, the higher the levels of market innovativeness, the less impact of the external collaboration on the NPD process. All other combinations of market information generation and intensity of external collaboration. These results support Hypothesis 5a.

5.4. Overview of hypotheses test

Returning to the model developed in the hypotheses chapter of this study I have added the significant effects (positive in green and negative in red). Five of the hypotheses were confirmed. One was found to be significant but contradictory to the hypothesized results, and six had no significant results in the regression equation.

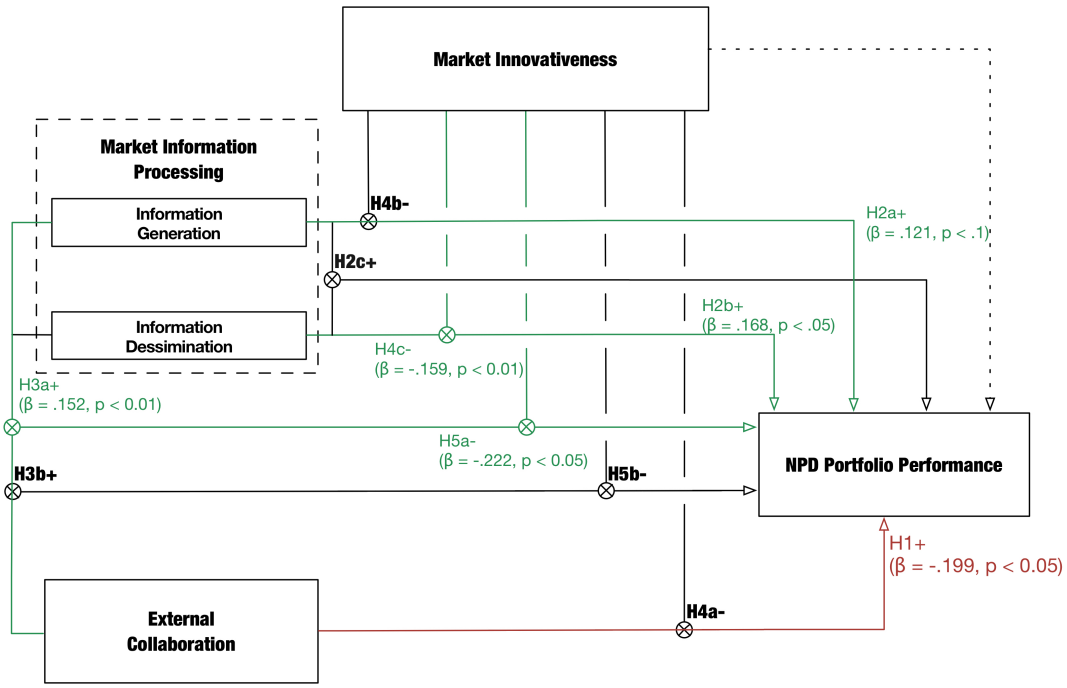


Figure 19. Conceptual model with results indicated.

- *Hypothesis 1: There is a positive direct relationship between the intensity (breath and depth) of the firm's external collaboration and NPD portfolio performance.* Significant but not confirmed - The external collaboration and NPD portfolio performance relationship was found to be significant but negative. This analysis indicates that external collaboration in an of itself is not a quick

fix for the limitations to the traditional closed model of new product development. Without strong information handling capabilities within the firm to handle the process, it does not appear external collaborators benefit the NPD portfolio performance.

- *Hypothesis 2a: There is a positive direct relationship between the intensity of the firms' market information generation and its NPD portfolio performance.* Confirmed - however the *p*-value for this effect was .07, indicating that the effect is right on the border of significance. However, the result confirms that the ability to identify sources of information and generate information from the impacts NPD portfolio performance.

- *Hypothesis 2b: There is a positive direct relationship between the intensity of the firms' market information dissemination and its NPD portfolio performance.* Confirmed - While market information generation was not found to benefit the NPD portfolio performance directly, market information dissemination, on the other hand, did have a significant and positive impact on NPD portfolio performance. The positive impact of market information dissemination confirms the importance of having formal and informal means of spreading information through the organization.

- *Hypothesis 2c: Combining market information generation and dissemination further enhance NPD portfolio performance;* No significant results.

- *Hypothesis 3a: Combining intensity of collaboration and market information generation further increases NPD portfolio performance;* Confirmed - The relationships become more complex as the interactions are added. As expected the intensity of external collaboration did have an impact, at least when market information generation was taken into account. Confirming that the capability to identify and acquire information from external sources is directly related to the firm's ability to benefit from external collaboration. The importance of mar-

ket information processing indicates that the firm's information processing capability to some extends is a predictor of its ability to use open innovation methods.

- *Hypothesis 3b: Combining intensity of collaboration and market information dissemination further increases NPD portfolio performance;* No significant results.

- *Hypothesis 4a: A firms' ability to benefit from external collaboration in the NPD process is weakened when the new product development program has a higher degree of market innovativeness.* No significant results.

- *Hypothesis 4b: A firms' ability to benefit from market information generation in the NPD process is weakened when the new product development program has a higher degree of market innovativeness;* No significant results.

- *Hypothesis 4c: A firms' ability to benefit from information dissemination in NPD is weakened when the new product development program has a higher degree of market innovativeness.* Confirmed - Market innovativeness proved to have a significant positive impact on NPD portfolio performance. However, the empirical analysis also shows that while market innovativeness can drive NPD performance, it is also a source of uncertainty that negatively impacts other drivers of NPD performance. One significant impact of this is the increased difficulty of disseminating market information in situations where the uncertainty of market information is a prominent factor.

- *Hypothesis 5a: The combined impact of external collaboration and market information generation on NPD performance becomes weaker when the NPD program has a higher degree of market innovativeness.* Confirmed - The otherwise positive impact of the combined intensity of external collaboration and market information processing constructs becomes negative when the second moderator of innovativeness is added to the equation.

- *Hypothesis 5b: The combined impact of external collaboration and market information dissemination on NPD performance becomes weaker when the NPD program has a higher degree of market innovativeness;* No significant results.

The results shows that the intensity of external collaboration, measured as the combined effect of all the firm external collaboration activities in NPD tells a more complicated story than was expected from the literature review (chapter 2). The large-scale deployment of external collaborators in an NPD project needs to be carefully considered. The firm's capability to benefit from multiple external collaborators in NPD is to a large extent dependent of the NPD teams capability to identify and collect information from external sources. However, the identifying and collect useful information from external sources becomes significantly more difficult the higher the level of innovativeness involved because of the increased uncertainty. The two dimensions of market information processing capability and market innovativeness are important indicators for a firm's ability to benefit from extensive external collaboration.

Chapter 6 — Discussion, Limitations, and implications

This chapter discusses the results and links the associated perspectives to existing literature. Furthermore, it examines the limitations and the potential for future research. The chapter concludes with implications for NPD managers.

This study began by observing that, despite the growing literature on external collaboration in NPD, clarity is required on two fundamental issues:

1. The growing need and demand for external collaboration when conducting NPD increases the complexity of the NPD process, especially when multiple external sources are involved simultaneously.
2. The innovation management literature has so far lacked a thorough empirical analysis of the capabilities needed to handle multiple external collaborators with NPD. The literature has instead focused on more abstract constructs to measure the success of integration, such as R&D intensity and the number of highly educated employees[267].

This study proposes that firms' information processing capability is a valuable perspective to apply when discussing how firms find and internalize externally sourced innovation and might prove a more comprehensive measure than R&D resource allocation. The literature review introduced several concepts; the main independent variables, external collaboration, information processing, and innovativeness, were framed by their theoretical background and related to the dependent variable of NPD portfolio performance. The field of research on the integration of information and external sources in the NPD process appears to be maturing. The literature review found that the effect of many external collaboration dimensions on NPD portfolio performance is still a subject

[267] See De Faria, Lima, and Santos (2010).

of debate. At the very least, our understanding of the complexities of integrating external sources of innovation is limited. To achieve successful NPD with the help of external collaborations, it appears that the collaboration must first put mechanisms in place to facilitate the transfer of information. The current study argues that a strong capability for information processing is an essential skill in collecting and disseminating relevant information to the parties involved in the NPD process[268]. With the theoretical background and the results of this study in mind, I will attempt to answer the research questions set forth at the beginning of the dissertation:

- How does the intensity of collaboration affect NPD performance when multiple collaborators are involved?
- To what extent does the firm-level capability of information processing define the relationship between external collaboration and NPD performance.
- How does the contingency of market innovativeness affect NPD with multiple external collaborators?
-

Eleven hypotheses related to the interaction between a firm's capability for processing market information and the extent of their external collaborations were tested. The analysis supports five of the eleven hypotheses and rejects seven.
Upon completion of this chapter, the reader should have a clear idea of the following:

- An overall picture of how the intensity of external collaboration affects NPD portfolio performance in light of perspectives from both the literature and the study results.
- The role of firm-level capabilities as a determinant of external collaboration success in NPD. In the case of this study, the moderating role of information processing tested as a key firm level capability in NPD with external collaborators involved.
- The ambiguity inherent when a high degree of market innovativeness is present leads to a potential for greater NPD performance, but with a greater degree of project un-

---

268 e.g. Tushman and Nadler (1978).

certainty.

6.1. Discussion

6.1.1. What characterizes the intensity of external collaboration?

To answer the first research question, I conducted an extensive analysis of the prior literature. Most studies describe external collaboration in NPD along several dimensions, with customers, suppliers, competitors, and public research institutions being the most dominant. All these dimensions were included in the current study, along with a fifth category covering other external experts. However, only a few prior studies have addressed the combined effect of these different types of external collaboration. *Laursen and Salter (2006)* approached the depth and breadth of external collaboration from a more fine-grained perspective, identifying eight potential collaborators. However, the current study extends the perspective on breadth and depth of external collaboration with the new measure of the intensity of external collaboration, thereby giving a clearer picture of the dynamics involved when multiple external collaborators work on the same project.

The five items selected for the external collaboration construct proved meaningful as a variable. A vast majority of survey respondents provided complete and meaningful answers. Nevertheless, contrary to the hypothesized relationship (H1), the external collaboration construct negatively affected innovation performance. While surprising, several other studies support this result. *Callahan and Lasry (2004)* argued that user involvement in the NPD process could be detrimental to innovation and firm performance. *Brockhoff (2003)* proposed that selecting customers who contribute to NPD poses a great challenge because firms have no guarantee of finding the right partner, and the negative consequences of poor collaboration can be significant. Nevertheless, a majority of research on the different types of collaborators examined in this dissertation indicates a predominantly positive impact on NPD performance. The construct of the intensity of external collaboration utilized in the current study, however, goes beyond collaboration

with any single collaborator type, e.g., customers, suppliers, etc. The results of the current study therefore reflect the intensity of collaboration across every type of collaborator involved in the firms' NPD projects. However, the results of this study are surprising given that a positive impact from the increasing intensity of external collaboration on NPD portfolio performance was expected. The negative effect found in the results in Chapter 5 are most likely a result of two possible explanations:

1) The research on the combined impact on NPD performance involving several different external collaborators is limited but offers a complex picture of the effectiveness of engaging with several types of collaborators simultaneously. As indicated in the literature review, *Nieto and Santamaría, (2007)* found that customers, suppliers, and university collaboration had a positive impact on NPD, while competitors did not. However, of more interest to this study is the fact that the impact was greater when the NPD project had several different types of external collaborators. The answer to this discrepancy between the results of the current study and those of *Nieto and Santamaría* might lie in another part of the innovation literature. *Katila and Ahuja, (2002)* examined whether "over-searching" for innovation opportunities might hinder NPD. The literature suggests two negative consequences of extremely high levels of innovativeness: it increases information costs and decreases reliability[269]. *Laursen and Salter's (2006)* work on the depth and breadth of innovation confirms this perspective. It appears that there is a tipping point after which external collaboration—in terms of breadth and depth—can negatively affect innovative performance[270].

> The possibility of over-search helps to create a more nuanced view of the role of openness, search, and interaction. The optimistic view of search ascribed great importance to the openness of firms to external sources in the development of new innovative opportunities. Our research supports this view, but it suggests that the enthusiasm for openness needs to be tempered by an understanding of the costs of such search efforts. It suggests external sources need to be managed carefully so that search efforts are not dissipated across too many search channels

269 See Rogers, 2003.

270 See chapter 2.3.5. — Quantitive research on External Collaboration.

- *Laursen and Salter, 2006.*

The argument that over-search is actually the cause of the negative effect of an increased intensity of external collaboration implies that firms engaged in extensive external collaboration fall victim to negative consequences related to the **intensity** of collaboration:

1. Path dependencies prevent the firm from seeing new opportunities in product development because they collaborate too much with the same external sources continuously[271].
2. Collaborating with the same external sources can also lead to rigidity, with the firm relying too heavily on its existing capabilities and overlooking input that diverges from its established approach in NPD[272].
3. Finding entirely new collaborators is a costly affair, and integrating their input is even more so because of increased requirements for changes in firm-level capabilities[273].

2) An additional explanation might be how the dependent variable is measured. NPD portfolio performance is measured across the entire NPD portfolio for a three-year span. Subsequently, the effects of external collaboration might appear as the expenditure of time and resources, and the positive impact could appear over a longer period. Previous research on collaboration with universities has focused on the impact on technical problem-solving and basic research aimed at long-term developments[274]. Therefore, the questionnaire might be the reason for the results. Previous research indicates that this might explain the results. *Dell'era and Verganti (2010)* found that the success of firms using external collaborators is not necessarily related to interaction with specific collaborators, i.e., in their study of designers as external collaborators it was the capability to

---

271 see Dosi, 1988.

272 See Katila and Ahuja (2002).

273 see Henderson and Clark (1990).

274 See Cassiman et al. (2010).

identify and manage a portfolio of collaborators that was a central capability for firms. Their results showed that, rather than providing a single idea or creative input, external sources provide input that can be exploited across several projects. In other words, the value of a single collaboration benefits from externalities generated by other collaborations. Furthermore, prior research and the results of the current study not only indicates the presence of synergies when more external collaborators are involved but also supports the notion that firm-level capabilities are of tremendous importance, in both identifying and managing external collaborators at the individual level and through the synergies that emerge when the project involves multiple external collaborators.

Given that many firms and industries must collaborate with multiple external partners in their NPD processes, to meet the need for increasing competitive output, it appears that handling these interactions is costly. A significant number of previous studies that have looked at a single type of external collaboration in NPD helps explain these challenges, e.g., collaboration with universities[275]. Research on supplier integration has found that, for collaboration to succeed, firms need active information collection capabilities, not only to determine suppliers' technical capabilities but also to establish a viable information flow[276]. Likewise, literature on collaboration with customers supports the need for firms to identify customers with relevant information for the NPD process[277]. The negative result observed here therefore relates to the resource requirements needed to handle multiple external sources simultaneously, along with the inability to capture the full effect of external collaborators in NPD because of the often intangible nature of their contributions to several projects. In other words, the intensity of external collaboration might negatively effect performance because of high resource demands for the identification and integration of external input. Nevertheless, an overall positive input of external collaboration cannot be ruled out because the benefits of the collaborations might be harder to track.

---

275 See Laursen and Salter (2004).

276 See Petersen, Handfield, and Ragatz (2003); Petersen, Handfield, and Ragatz, (2005).

277 See Urban, G. L., & von Hippel, E. (1988).

6.1.2. How does the firm's market information processing capability impact the firm's ability to benefit from external collaborators in NPD projects?

Existing perspectives on the integration of external collaboration have so far been limited in their explanatory power. A majority of research on this problem has focused on the concept of absorptive capacity[278]. The literature on absorptive capacity focuses on the firm's internal R&D expenses as indicators of its capability to process externally generated information and apply it in the NPD process[279]. This lack of focus on a specific firm-level capability has led to a gap in our understanding of the complex dynamics involved in making external collaboration work in NPD. The current study attempts to address this gap by applying information processing. However, the two information processing constructs used in the study, i.e., information generation and dissemination, provided a rather complex image in serving as both independent variables and moderating effects in the finished model, as presented in Chapter 5.

Both market information constructs had a significant and positive effect on NPD portfolio performance in the model (H2a and H2b). As expected based on the literature[280], this speaks to the importance of establishing processes for identifying, collecting, and disseminating information from the market on NPD portfolio performance. The results highlight the importance of being mindful of market tendencies and developments when conducting NPD regardless of requirements or aspirations for more or fewer external sources in the NPD process. However, the role of information processing becomes more complex when looking at the interaction between the two market information constructs (H2c). While the current study observes no direct effect of the interaction between market information generation and market information dissemination on NPD portfolio performance, it reveals a direct and positive effect of both independent variables when measured separately. However, it does not appear that a strong firm-level capability for both of these processes compounds the effects of each one separately. From the exami-

278 See Cohen and Levinthal (1990); Spithoven, Clarysse, and Knockaert (2011).

279 See Fabrizio, 2009; Rothaermel & Alexandre, 2009

280 e.g., Narver and Slater (1990); Cillo, De Luca, and Troilo (2010).

nation of the data and the literature review, the temporal nature of information processing may provide an explanation for this effect[281]. The information must be identified and generated before it can be disseminated, and standardizing the variables shows no additional impact on NPD portfolio performance. However, the results of the current study confirm that the market information constructs are in fact two separate capabilities and must be developed as such, with effort devoted to both.

The importance of market information processing increases further when examined together with the intensity of collaboration. The positive impact of market information generation combined with an increased intensity of external collaboration on NPD portfolio performance (H3a) stresses the importance of having established, comprehensive processes to identify and collect information from the market. These capabilities must be in place before attempting to engage in extensive collaboration with external sources in the NPD process. Moreover, It appears that having a developed robust market information generation capabilities are important for project with both high and low intensity of external collaboration. Without defined and established procedures for market information generation the effectiveness of collaborations with external sources decreases. In other words, if the intensity of external collaboration is high or low, established processes for information generation are of great importance, and a more ad hoc approach to information generation has a noticeable detrimental effect on NPD portfolio performance.

The interaction between market information dissemination and intensity of external collaboration did have a significant positive impact on NPD portfolio performance (H3b). From the literature review, I would expect the capability to disseminate market information from NPD project with many external collaborations to benefit the NPD process in three distinct but interconnected ways: 1) a high level of knowledge dissemination leads to quick awareness of external or internal surprises. 2) The dissemination mitigates con-

---

281 See Maltz and Kohli (1996); Morgan, Vorhies, and Mason (2009).

flicts within the firm by corroborating or refuting assumptions in the decision-making process. 3) The ability to disseminate helps to create a shared understanding of market demands, technological developments, and competitors' actions within the organization across all functions and hierarchical levels[282]. However, the lack of significance probably indicates a limitation in the regression equation, where the measurement of the intensity of external collaboration is significantly negative and market information dissemination is significantly positive. The combined effect of the two standardized variables is probably harder to capture later in the information processing flow. In other words, the study found that the intensity of external collaboration on NPD portfolio performance did have an impact when moderated with market information generation because the benefits of interaction with external sources and generating information both reside with the NPD team members, i.e., the respondents for the study, making the effect immediately traceable within the data. However, the interaction with market information dissemination reflects the effectiveness with which the information moves on from this group to the rest of the firm. This later stage in the information processing flow could very well be harder to capture within the data.

6.1.3 The contingency of market innovativeness

The current study hypothesized that external collaboration and the market information generation variables were likely to benefit from the contingency of innovativeness. However, the literature review in Chapter 2 made it clear that the relationship between market innovativeness and NPD performance is complicated, with market innovativeness serving as both a predictor of NPD performance and a source of uncertainty in the NPD process. The hypotheses related to the contingency of market innovativeness in this study confirm this complicated relationship, through both the direct observable significant effects and more indirectly through the parts of the analysis revealing no effects.

Of the 11 hypothesized relationships in the study, five involved the interaction with

---

282 See Im and Workman (2004).

market innovativeness, and the analysis confirmed two. The five hypothesized relationships will be treated sequentially.

The Intensity of external collaboration on NPD portfolio performance relationship moderated by market innovativeness (H4a) is conceptually complex. As previously discussed, I expected that this interaction would affect NPD portfolio performance negatively because of the uncertainty factor introduced by the fact that market innovativeness raises the cost of coordination and integration[283]. However, the lack of significant results might be explained by whom the firm in question chooses to work with. The intensity of external collaboration construct does not measure the level of familiarity between the firm and its external collaborators. Working closely with established collaborators has both benefits and drawbacks, as discussed in section 6.1.1. On the benefit side, working with established collaborators reduces costs and increases the reliability of NPD efforts. However, it is also more likely that the collaboration will result in more incremental innovation in path dependencies[284]. Turning to new collaborators with whom the firm has no prior connection is more likely to lead to the discovery of something very new. This, however, comes at the risk of increased costs in terms of the identification of new collaborators and the collection of information from them in a usable format for the firm conducting the NPD[285]. Hence, the complexity of the intensity of external collaboration can be hard to capture within the data. Furthermore, the complexity grows when market innovativeness is added as a moderating effect because it acts as a driver of innovation with the potential to come up with something radically new. This novelty will lead to increased market sales and revenue, but it also introduces a level of uncertainty, which increases the management costs of the NPD process[286]. Given the dichotomous nature of both interacted independent variables, the regression equation likely does not capture the actual relationship between the two.

---

283 See Hauschild and Salomo (2011).

284 See Nieto and Santamaria (2007).

285 See Leonard-Barton (1995).

286 See Green, Gavin, and Aiman-Smith (1995).

Based on the review of prior literature on market information processing (Chapter 2) and the subsequent development of the hypotheses (Chapter 3) it was expected that both market information generation and dissemination would be negatively related to market innovativeness when interacted. However, market information generation had no significant impact on NPD performance when the moderating effect of market innovativeness was taken into account. Market information dissemination was, as hypothesized, negatively related to performance when moderating for market innovativeness.

Several observations can explain the lack of significant results from the interaction of market information generation with market innovativeness (H4b). When tested separately, the study found a significant positive impact on NPD portfolio performance for both market information processing constructs. However, having both present at the same time does not appear to add any further effect on NPD portfolio performance. A possible explanation for this could lie within the conceptualization of the variables. On one hand, the study measures market information generation along items concerned with processes for the identification and collection of information from market actors. On the other hand, the study measures market innovativeness along dimensions related to newness to customers, the industry, etc. The reason that the study found no interaction effect between the two variables on NPD portfolio performance could therefore be related to how the firm uses its information in the NPD process. The firm might generate a significant amount of information that might be related to an NPD process but not directly related to innovativeness. Hence, market information generation is related to ongoing general activities, and market innovativeness is related directly to the perceived novelty of the products introduced. The conceptualization results in no combined effect of the two factors because the presence of one does not affect the presence of the other unless other factors are also present.

The study also found that information dissemination has a direct relationship with NPD performance in our study when combined with market innovativeness (H4c). However,

in NPD programs with a high degree of innovativeness, trying to disseminate information gained from the market throughout the organization is detrimental to NPD performance. This could be a result of several factors: A) the act of disseminating information in a project that lies significantly outside the normal operations for a firm leads to a degree of insecurity and confusion among people not intimately and directly involved with the NPD project, and B) the effort expended in bringing the entire firm up to date on both present and future market requirements could require more resources than it generates in terms of NPD performance. Previous research by *Ottum and Moore (1997)* supports this result. *Hultink et al. (2011)* may offer an explanation for this relationship, as they found that information dissemination was only significantly related to NPD performance if the quality of the information was high. In radical NPD programs, obtaining reliable, quality information from the market is unlikely, and the relationship between information dissemination and NPD performance therefore suffers. The exploration of this interaction effect using simple slopes reveals that a strong capability for market information dissemination is not without merit if the NPD project is incremental in nature. Trying to disseminate information in radical NPD projects from the market results in a significant negative impact on NPD performance. In the case of incremental NPD projects, it results in a slight positive impact.

So far, the current study has established that an increased intensity of external collaboration effects NPD portfolio performance negatively when measured as a direct effect. However, a positive and significant gain in NPD performance occurs when the firm's capability of market information generation is taken into account. As a final step, the analysis introduced market innovativeness in the intensity of external collaboration interaction with market information processing.

The study tested the intensity of external collaboration on NPD performance using both market information dissemination and market innovativeness as moderators. However, the analysis revealed no effect. In all likelihood, the explanation for the lack of effect extends back to the previous interaction between the intensity of external collaboration

and market information dissemination on NPD portfolio performance.

As with the other interactions with market innovativeness, this study hypothesized a negative impact when introducing the market innovativeness construct to the otherwise positive interaction of an increased intensity of external collaboration and market information generation on NPD portfolio performance. The confirmation of this hypothesis leads to several interesting observations. First, the study already established that the intensity of external collaboration had a negative impact on NPD portfolio performance, while market information generation had a positive impact. When measuring it as an interaction effect, the study found a positive effect of the interaction. These results indicate that collaborating with many different sources in the NPD process is a very resource-intensive process that requires established processes for identifying and collecting information from the market. Second, the analysis found a negative result after introducing market innovativeness, which indicates that, while having many external collaborators contribute to NPD performance when the right firm-level capabilities are present, i.e., market information generation, this becomes detrimental when taking newness to the market into account, i.e., market innovativeness. In other words, the results confirm the importance of developing capabilities for market information generation, which overall has a significant positive impact on NPD portfolio performance. However, in a situation with a high degree of innovativeness, the best results are achieved with low external collaboration intensity. The results also highlight the circumstances under which the firm struggles most to benefit from collaboration with many different external sources. In situations where firms' capability for information generation is relatively low but they collaborate intensively with many different sources on NPD projects with relatively low levels of market innovativeness, the study observes a detrimental effect on NPD portfolio performance. In other words, when the firms have few to no established procedures for processing information and engage in many intense collaborations with many external sources on projects with comparatively low earnings potential, the resource expenditures exceed the benefits of collaboration.

From a contingency perspective, the more collaborators involved in the NPD project and the higher the level of collaboration required, the more likely it is that the integration of the external sources will require changes to the firm's structure. Furthermore, the higher the intensity of external collaboration, the more likely it is to require changes in networks of relationships and communication structures both within and outside the firm. In the external collaboration literature, little attention has been drawn to the fact that, with more collaborators and deeper levels of interaction, more complex problems are likely to arise when attempting to establish and manage these collaborations.

6.1.4. Summarizing the discussion

These results lend partial support to the theoretical framework, allowing for the development of a model that highlights both the impact and interaction of different types of information into an NPD project. By looking at the combined impact of market information generation and external collaboration on NPD performance, the current study provides new insight into how these two constructs interact in a broad section of Danish and Austrian firms. While market information generation seems to have direct beneficial effects on NPD portfolio performance, it is also a vital component when dealing with external collaboration. Therefore, it appears that external collaboration cannot stand alone but functions only in synergy with market information generation. Furthermore, it also appears that this interaction is only effective in incremental NPD programs. These results are in line with previous research by *Callahan and Lasry (2004)*, which found that customer input was important for NPD programs, especially NPD aimed at developing products with a low level of market newness, but customer importance dropped off for higher levels of market novelty. The study by *Zhou, Yim, and Tse (2005)* further expanded on this and found that customers had difficulty contributing to NPD when the project had a high degree of market innovativeness. From the literature, it appears that there is an overall consensus regarding the importance of choosing the right collaborator[287]. The current study used market information generation as an indicator of the firm's ability to find and collect information from the proper sources depending on the

287

situation. However, the study extends this research by hypothesizing on the importance of the intensity of external collaboration, measured across types of collaborators, i.e., universities, suppliers, etc., as well as the perceived level of dependency of the firm on its information in NPD. The successful use of external collaborators in NPD therefore depends on both the intensity of the collaboration across the different collaborator types and the firm's ability to select, collect, and disseminate the information.

In other words, it seems that the complexity of integrating external sources of innovation into NPD depends on two factors. First, the firm's capability for processing market information appears to be an essential component in its successful use. Second, the contingency of innovativeness is an important factor when determining whether external collaboration is appropriate for an NPD project. The more radical the project, the less the effect external collaboration has before eventually becoming detrimental to NPD performance even when taking market information processing capability into account. This effect means that market information generation plays an important role in the relationship between external collaboration and NPD performance.

This study hypothesized a complex relationship between the intensity of external collaboration and NPD performance, which was conditional on several other capabilities and contingencies. Overall, the study findings indicate that collaborating closely with many different external sources is resource-intensive and requires some strong firm-level capabilities, i.e., market information processing. However, the results also indicate that, if these capabilities are in place, managers can harness the external sources of innovation with caveats:

1. If the project aims at producing a project that is very new to the market, information generation should be high for the NPD team, but the intensity of external collaboration should be carefully managed. Relying on input from many different sources increases the likelihood of over-searching for innovations.

2. The attempt to disseminate the generated information should be controlled for because of the potential for resistance within the firm and the high cost of information transfer.
3. If the NPD team does not have a strong capability for market information generation, it should also be wary of relying too much on many external sources even for incremental innovations, as there is a risk of over-using resources in the management of these collaborators.

6.2. Implications for innovation research

This study provides important insights into the complex relationship between firms' intensity of external collaborations and their NPD portfolio performance. I have discussed some of the firm-level capabilities needed to facilitate collaboration with multiple external sources involved in NPD and taken the effect of market innovativeness into account. The study addresses some of the challenges that firms face when engaging with multiple external collaborators simultaneously in their NPD process. Nevertheless, from an innovation research perspective, better methods are still necessary to understand how to make external collaboration work in highly innovative contexts and in finding the right theoretical perspectives when examining the firm-level capabilities and contingencies that affect external collaborations in NPD.

We can draw several implications from the introduction of the intensity of external collaboration variable. First, it expands the existing literature by allowing for a multi-dimensional conceptualization of a phenomenon within a single construct. This construct extends the previous research by *Laursen and Salter (2006)* by combining their breadth and depth variables into a single construct, thereby allowing for a new perspective summarized as the intensity of external collaboration. As both research and practice matures around the different conceptualizations of external collaboration in NPD, e.g., open innovation or user-driven innovation, the importance of considering the intensity of collaboration will also increase in terms of harnessing benefits and handling risks. On the benefits side, the potential for increased information flow and possible synergies by

collaborating with several different actors needs to be explored, thereby extending and expanding on the work by *Un, Cuervo-Cazurra, and Asakawa (2010)*. On the risk side of the equation, the resource requirements for a very open approach to innovation, i.e., a high intensity of external collaboration, needs additional study.

The current study also contributes to the discussion of the importance of firm-level capabilities for making collaboration with external sources work. Thus, beyond the direct results indicating the importance of market information processing, researchers need to expand the overall focus on firm-level capabilities. The current study controlled for the level of formalization in the NPD process, but several other aspects of NPD project management likely affect the interaction directly. In other words, the presence of project management systems[288] likely plays an important role in complex projects with multiple external collaborators engaged simultaneously. However, whether the presence of project management systems is beneficial because of clarity in the decision-making process or detrimental because of the difficulties of integrating external sources into internal processes remains to be seen.

Finally, by constructing the intensity of external collaboration variable, the study demonstrates that involving multiple external sources in NPD can be detrimental to the performance of the NPD portfolio. This study demonstrates the needed firm-level capabilities to benefit from this interaction by including market information processing. However, another stream of research within the NPD management context shares in the implications of the current study. Significant research has illustrated the role of intermediaries in NPD[289]. This research indicates that a complex relationship exists between intermediaries and firm-hosted NPD involving external sources. Including the "intensity of external collaboration" perspective could provide valuable insight into the role of intermediaries in the NPD process.

---

288 See Cooper, 2008; Schultz, Salomo, de Brentani, and Kleinschmidt, 2013.

289 See Sieg, Wallin, and von Krogh (2010).

6.3. Limitations and future research

The current study has three limitations that can be addressed in future research. The process of conducting this study and the concrete outcomes, more specifically, led to these reflections concerning future research directions. Examination of these perspectives would complement the findings of the current study. It would enhance our understanding of the dynamics present within firms when their NPD projects involve multiple external collaborators, both contextually and methodologically, to an extent not possible within a single study.

First, this study used market innovativeness as an indicator for the level of uncertainty involved in a project. Previous research has found that products unfamiliar to the market or targeting entirely new customer segments increased the difficulty of collecting reliable market information. Subsequently, such products are also harder for the customers, as external collaborators, to contribute to[290]. Products with a higher level of innovativeness also require more in terms of project management[291]. The role of project management in developing innovative new products with multiple external collaborators is, to an extent, an underlying theme of the current study, without being addressed directly. The items used from the survey in the construction of the variables all relate to firms' ability to collect data, disseminate it through formal and informal means, collaborate with external sources, etc. All these items therefore have an element of project management, so project management becomes a sort of meta theme within this study. Future studies could address this implicit application of project management more concretely, thereby providing an important perspective when examining highly complex projects involving many external collaborators. The research could be extended by looking at the role of formal and informal project management processes. Formalized processes offer clear decision making[292] and reduced task ambiguity[293], and they make tacit organiza-

290 See Zhou, Yim, and Tse, 2005.

291 See Grant, 1996.

292 See Schultz, Salomo, de Brentani, and Kleinschmidt (2013).

293 See Tatikonda and Montoya-Weiss (2001).

tional routines explicit. Informal routines are often both cheaper and faster than their formal counterparts but also harder to facilitate[294]. Extending the methodological approach of this study, a shift in focus from firm-level information processing capabilities to the formal and informal structures used in NPD management could provide valuable insight into how to structure collaboration-intensive NPD projects.

Second, the literature shows that innovativeness in general and market innovativeness specifically are complex constructs when related to NPD performance. NPD projects with a high degree of innovativeness have a higher impact on performance if they are successful[295]. However, higher innovativeness also significantly increases complexity and uncertainty, which increases the likelihood of increased resource expenditures or outright project failure[296]. The literature suggests that external collaborators are more likely to have valuable information that is useful for radical NPD process[297]. The current study did not find such an effect when examining the intensity of external collaboration. Previous research into innovation champions suggests that, for NPD projects with a high degree of innovativeness, individuals within a firm may act as champions for the project. These individuals facilitate the necessary backing and connections for bringing it to fruition[298]. Considering the information champion literature in light of the concept of information processing seems to indicate that promoters are those who facilitate, generate, and disseminate information for the firm. They might therefore serve as a key component in understanding how to manage multiple external collaborators in NPD. In other words, innovation champions could counter the complexity and uncertainty of highly innovative NPD projects with multiple external collaborators. In practical terms, the current study addressed the portfolio level of NPD, while the innovation champion literature takes a project-level approach. However, moderating for the presence of inno-

294 See Brown and Duguid (2002).

295 See Jordan and Segelod (2006).

296 See Green, Gavin, and Aiman-Smith (1995).

297 See Faems, Van Looy, and Debackere (2005).

298 See Gemünden, Salomo, and Hölzle (2007); Whelan, Teigland, Donnellan, and Golden (2010).

vation champions could provide interesting insights. This approach would contribute the literature on external collaboration in NPD and expand our knowledge of the effect of innovation champions in complex NPD projects involving several external sources.

Third, this study measured the intensity of external collaboration as a construct that captures two dimensions: 1) with whom the firm collaborated and 2) whether the collaboration was limited or extensive. These two elements together comprised the intensity of external collaboration factor. However, another dimension that could add valuable insight into the effect of intensity of external collaboration on performance was the level of familiarity between the firm and its collaborators; i.e., were the collaborators the same across many NPD products, or did they change from project to project? The data available for this study did not reveal this information. However, future studies could examine the level of familiarity in collaborations to determine whether it affects NPD performance. From the study conducted here, we cannot observe whether familiarity from previous NPD projects is more likely to increase or decrease the impact of the intensity of external collaboration on NPD performance. Using the same external collaborators repeatedly reduces the likelihood of errors and facilitates the development of routines[299]. Increased familiarity is also likely to make a search more predictable, as the information exchange is familiar. Consequently, NPD tasks can be effectively broken down into more manageable problems, and activities can be sequenced in an efficient order[300]. Likewise, repeated usage of a given set of concepts can lead to a significantly deeper understanding of those concepts and boost a firm's ability to identify valuable elements within them. However, relying on established collaborations for NPD could also lead to path dependencies, which would limit the likelihood of the development of highly innovative new products. The latter argument indicates that collaborating with new sources of information is more likely to enable the firm to approach problems in new ways[301]. Furthermore, finding new collaboration sources in NPD is also likely to

299 See Levinthai and March, 1981.

300 See Eisenhardt and Tabrizi (1995).

301 e.g., March (1991).

enhance firms' ability to recombining existing assets into new product offerings[302]. Including a variable for familiarity or splitting the data into the intensity of external collaboration with either established or new collaborators would greatly extend the search depth and search scope perspective[303] touched upon in the discussion. The perspectives collected from a questionnaire format could be further enriched with qualitative measures. Specific external collaborator-firm relationships could be examined. In-depth interviews could shed light on the effectiveness of continuous patterns of external collaboration in NPD.

6.4. Implications Managers

The results of the current study pose some concrete managerial implications. I discuss many of these observations in the literature review in Chapter 2, through the hypothesis development in Chapter 3, and in the beginning of this chapter in the discussion. However, both to ensure clarity and to prevent the results from being interpreted beyond their practical validity, this section will briefly present the challenges put forth in this study and further develop the implications that stem from it.

The results represented in Chapter 5 and discussed in Chapter 6 show the complexity involved in modern NPD projects. Both the intensity of external collaboration and market innovativeness showed a very complicated relationship with NPD performance. Likewise, the role of market information processing was overall positive, but its effectiveness depends on the level of innovativeness, which has a strong impact. To conclude this study, I present four practical implications for innovation practitioners, resulting in concrete, pragmatic guidelines for the successful integration of external collaborators in NPD.

6.4.1. A focused market information strategy leads to better performance

Establishing the ability to select external collaborators is undoubtedly a key capability

---

302 e.g., Fleming and Sorenson (2001); Nelson and Winter (1982).

303 See Katila and Ahuja, 2012.

for managers engaged in NPD projects. Previous research found that market information had a direct and positive effect on performance, and the current study confirms this. Market information processing and market information dissemination both proved important and distinct activities that the firm must engage in as a core capability for successful NPD. By delving deeper into the actual constructs that comprise the market information processing in the study, I can make some direct recommendations for managers:

A. Establish a set of selection criteria for selecting identifying potential collaborators.

B. Establish the requirements for which market sources should be analyzed.

B. Establish clear methods for collecting the data.

C. Develop a culture for "informally" spreading market information throughout the organization.

B. To help the informal methods of information dissemination, formal structures and channels for information sharing should be in place.

6.4.2. Balancing resource gains and costs from multiple external collaborations

The research on collaboration with external sources in NPD forms a complex picture of the effectiveness of external sources under a wide variety of circumstances and conditions. Nevertheless, a majority of the research supports an overall positive impact on NPD performance[304]. This study shows a slightly more complex picture, where the intensity of external collaboration has a negative impact on NPD performance unless the firm also has capabilities for market information generation. For managers, there are two important implications:

A. Collaborating with many external sources when developing new products is a resource-heavy task that has the potential to demand more of the NPD team's resources than the output of the collaboration can justify.

B. If the NPD team has a strong capability for market information generation, they are

304 e.g., Narver, Slater, and Maclachlan, 2004; Veldhuizen, Hultink, and Griffin, 2006.

much better equipped to handle the intensity of the collaboration process. Therefore, before engaging in collaboration with multiple external sources in the NPD process the firm should have the following capabilities in place: the ability to identify actors with useful information, a clear collaboration selection process, and proven methods for collecting the information.

6.4.3. Radical innovation challenges the internal acceptance of market information

While my initial findings confirm the benefits of market information dissemination as having a direct and positive impact on NPD portfolio performance, the inclusion of market innovativeness changes the picture. While both constructs had a positive impact on NPD portfolio performance, this changed when both existed in the NPD process. From a managerial perspective, this has two potential implications:

A. Resistance to the information within the firm because it comes from sources that are not universally trusted, which results in a "not invented here" reaction.

B. The information might have characteristics that make it resource intensive for the NPD team to "translate" to the rest of the organization, e.g., anecdotal evidence within a firm used for numerical analysis.

Managers should therefore be careful about what information they disseminate, how they do it, and to whom they five it.

6.4.4. The challenging use of very new products as performance drivers

While the current study did not hypothesize a direct effect of market innovativeness on NPD portfolio performance, I tested it independently for model completeness. This result, when examined in the context of our prior knowledge on the effects of innovativeness, indicates that new product portfolios should include projects with varying degrees of newness to the market. It is crucial for NPD portfolio performance that the new product portfolio also includes more radical innovations, not only incremental, short-term efforts. Firms need to dare and invest in very new products to be successful because a higher degree of innovativeness leads to more pronounced effects on perfor-

mance.

One of the primary contributions of this study is its focus on the dichotomous nature of market innovativeness. If a firm successfully launches a product that targets a new customer segment or opens an entirely new market, the impact on firm performance can be enormous. However, in the development process, the uncertainties involved pose a danger in terms of both product success and the resources needed to handle task uncertainty.

For managers, this means that a strong capability for market information generation always appears to have a direct positive impact on NPD. Moreover, if the level of market innovativeness is high, it is optimal to limit the intensity of external collaborators involved in the NPD project, i.e., the number of collaborators and the degree to which the firm relies on them, unless the firm has strong market information generation capabilities facilitate the interaction, and even then, the results are limited for very innovative NPD projects. Hence, managers should note that the firm's market information generation capability seems to be a significant driver of NPD performance. This capability should be developed with or without the intention to use external sources in NPD.

References

Adler, P. S. (1995). Interdepartmental interdependence and coordination: The case of the design/manufacturing interface. Organization Science, 6(2), 147-167.

Afuah, A., & Tucci, C. L. (2012). Crowdsourcing As a Solution to Distant Search. Academy of Management Review, 37(3), 355–375.

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: A longitudinal study. Adminstrativ Science Quarterly, 45(3).

Aiken, L. S., & West, S. G. (1991). Multiple regression: Testing and interpreting interactions. Thousand Oaks, CA: Sage Publications.

Akgun, A. E., Lynn, G. S., & Reilly, R. (2002). Multi-dimensionality of learning in new product development teams. European Journal of Innovation Management, 5(2), 57-72.

Ali, A., Krapfel, R., & Labahn, D. (1995). Product Innovativeness and Entry Time and Break-even Time Strategy : Impact on Cycle. Journal of Product Innovation Management, 6782(94), 54–69.

Allen, T. J. (1971). Communications, technology transfer, and the role of technical gatekeeper. R&D Management, 1(1), 14-21.

Almirall, E., & Casadesus-Masanell, R. (2010). Open Versus Closed Innovation: A model of Discovery and Divergence. Academy of Management Review, 35(1), 27–47.

Ancona, D. G., & Caldwell, D. F. (1992). Bridging the boundary: External activity and performance in organizational teams. Administrative science quarterly, 634-665.

Atuahene-Gima, K. (1995). An exploratory analysis of the impact of market orientation on new product performance a contingency approach. Journal of Product Innovation Management, 12(4), 275–293.

Atuahene-Gima, K., & Evangelista, F. (2000). Cross-Functional Influence in New Product Development: An Exploratory Study of Marketing and R… D Perspectives. Management Science, 46(10), 1269-1284.

Atuahene−Gima, K., Slater, S. F., & Olson, E. M. (2005). The Contingent Value of Responsive and Proactive Market Orientations for New Product Program Performance. Journal of product innovation management, 22(6), 464-482.

Aylen, J. (2010). Open versus closed innovation: development of the wide strip mill for steel in the United States during the 1920s. R&d Management, 40(1), 67-80.

Baldwin, C., & Hippel, E. Von. (2011). Modeling a Paradigm Shift : From Producer Innovation to User and Open Collaboration Innovation. Organization Science.

Barczak, G., & Mcdonough Iii, E. F. (2003). Leading global product development teams. Research Technology Management, 46(6), 14.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of management, 17(1), 99-120.

Bartl, M., Füller, J., Mühlbacher, H., & Ernst, H. (2012). A Manager's Perspective on Virtual Customer Integration for New Product Development. Journal of Product Innovation Management, 29(6), 1031–1046.

Belderbos, R., Carree, M., & Lokshin, B. (2004). Cooperative R&D and firm performance. Research Policy, 33(10), 1477–1492.

Belderbos, R., Carree, M., & Lokshin, B. (2006). Complementarity in R & D Cooperation Strategies. Review of Industrial Organization, 28(4), 401–426.

Belderbos, R., Faems, D., Leten, B., & Looy, B. Van. (2010). Technological Activities and Their Impact on the Financial Performance of the Firm: Exploitation and Exploration within and between Firms. Journal of Product Innovation Management, 27(6), 869–882.

Belussi, F., Sammarra, A., & Sedita, S. R. (2010). Learning at the boundaries in an "Open Regional Innovation System": A focus on firms' innovation strategies in the Emilia Romagna life science industry. Research Policy, 39(6), 710–721.

Benassi, M., & Di Minin, A. (2009). Playing in between: patent brokers in markets for technology. R&D Management, 39(1), 68–86.

Bercovitz, J. E. L., & Feldman, M. P. (2007). Fishing upstream: Firm innovation strategy and university research alliances. Research Policy, 36(7), 930–948.

Bergh, D. D. (1998). Product-Market Uncertainty, Portfolio Restructuring, and Performance: An information-processing and Resource-Based View. Jounal of Management, 24(2), 135–155.

Bierly III, P. E., & Daly, P. S. (2007). Sources of external organisational learning in small manufacturing firms. International Journal of Technology Management, 38(1-2),

45-68.March (1991).

Bogers, M., & Lhuillery, S. (2011). A Functional Perspective on Learning and Innovation: Investigating the Organization of Absorptive Capacity. Industry & Innovation, 18(6), 581–610.

Bogers, M., & West, J. (2012). Managing Distributed Innovation: Strategic Utilization of Open and User Innovation. Creativity and Innovation Management, 21(1), 61–75.

Bonaccorsi, A., & Lipparini, A. (1994). Strategic partnerships in new product development: an Italian case study. Journal of Product Innovation Management, 11, 134–145.

Brettel, M., & Cleven, N. J. (2011). Innovation Culture, Collaboration with External Partners and NPD Performance. Creativity and Innovation Management, 20(4), 253–272.

Brockhoff, K. (2003). Customers' perspectives of involvement in new product development. International Journal of Technology Management, 26(5-6), 464-481.

Brown, J. S., & Duguid, P. (2002). The social life of information. Harvard Business Press.

Bruneel, J., D'Este, P., & Salter, A. (2010). Investigating the factors that diminish the barriers to university–industry collaboration. Research Policy, 39(7), 858–868.

Calantone, R. J., Chan, K., & Cui, A. S. (2006). Decomposing Product Innovativeness and Its Effects on New Product Success. Journal of Product Innovation Management, 23(5), 408–421.

Calantone, R., Garcia, R., & Dröge, C. (2003). The Effects of Environmental Turbulence on New Product Development Strategy Planning. Journal of Product Innovation Management, 20, 90–103.

Callahan, J., & Lasry, E. (2004). The importance of customer input in the development of very new products. R&D Management, 34(1986).

Carlile, P. (2002). A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development. Organization Science, 13(4), 442–455.

Carlile, P. (2004). Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries. Organization Science, 15(5), 555–568.

Cassiman, B., & Veugelers, R. (2006). In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. Management Science, 52(1),

68–82.

Cassiman, B., Di Guardo, M. C., & Valentini, G. (2010). Organizing links with science: Co-operate or contract? Research Policy, 39(7), 882–892.

Ceccagnoli, M., Graham, S. J. H., Higgins, M. J., & Lee, J. (2010). Productivity and the role of complementary assets in firms' demand for technology innovations. Industrial and Corporate Change, 19(3), 839–869.

Chandler, A. (1977). The visible hand Cambridge. Massachusetts: s/e.

Chatterjee, R., & Eliashberg, J. (1990). The Innovation Diffusion Process in a heterogeneous Population: A Micromodeling Approach. Management Science, 36(9), 1057–1079.

Chesbrough, H. W. (2003). Open Innovation: The New Imperative For Creating and Profiting from Technology. Boston: Harvard Business School Press.

Chesbrough, H. W. (2006). Open Business Model: How to Thrive in the New Innovation Landscape (1st ed.). Boston: Harvard Business School Press.

Chesbrough, H. W., & Appleyard, M. M. (2007). Open Innovation and Strategy. California Management Review, 50(1), 57–77.

Chesbrough, H., & Bogers, M. (2014). Explicating Open Innovation : Clarifying an Emerging Paradigm for Understanding Innovation. In W. V. and J. W. Henry Chesbrough (Ed.), New Frontiers in Open Innovaion (1st ed., pp. 1–37). Oxford: Oxford University Press.

Chesbrough, H., & Crowther, A. K. (2006). Beyond high tech: early adopters of open innovation in other industries. R&D Management, 36(3), 229–236.

Chesbrough, H., & Rosenbloom, R. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin‐off companies. Industrial and Corporate Change, 11(3), 529–555.

Chiaroni, D., Chiesa, V., & Frattini, F. (2010). Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries. R&D Management, 40(3), 222–245.

Ciccantelli, S., & Magidson, J. (1993). Consumer Idealized Design: Involving Consumers in the Product Development Process. Journal of Product Innovation Management, 10(4),

341–347.

Cillo, P., De Luca, L. M., & Troilo, G. (2010). Market information approaches, product innovativeness, and firm performance: An empirical study in the fashion industry. Research Policy, 39(9), 1242–1252.

Clark, K. B. (1989). What Strategy Can Do for Technology. Harvard Business Review, 94–98.

Coase, R. H. (1993). The nature of the firm (1937). The Nature of the Firm: Origins, Evolution and Development. Oxford University Press: New York, 18-33.

Cohen, W. M., & Klepper, S. (1996). Firm Size and the Nature of Innovation Within Industries: The Case of Process and Product R&D. The Review of Economics and Statistics, 78(2), 232–243.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity : A New Perspective on Learning and Innovation. Administrative Science Technology, 35(1), 128–152.

Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2002). Links and Impacts: The Influence of Public Research on Industrial R&D. Management Science, 48(March 2015), 1–23.

Cooke, P., & Schienstock, G. (2000). Structural Competitiveness and Learning Regions. Enterprise and Innovation Management Studies, 1(3), 265–280.

Cooper, R. G. (1979). The Dimensions of Industrial New Product Success and Failure. Journal of Marketing, 43(3), 93–103.

Cooper, R., & Jones, T. (1995). The interface between design and other key functions in new product development.In M. Bruce, & W. G. Biemans (Eds.), Product development : meeting the challenge of the design marketing interface. (pp. 81-97). Chichester: Wiley.

Cummings, J. N. (2004). Work Groups, Structural Diversity, and Knowledge Sharing in a Global Organization. Management Science, 50(3), 352–364.

Dahlander, L., & Gann, D. M. (2010). How open is innovation? Research Policy, 39(6), 699–709.

Dahlander, L., & Magnusson, M. (2008). How do Firms Make Use of Open Source Communities? Long Range Planning, 41(6), 629–649.

Day, G. S. (1994). The capabilities of market-driven organizations. The Journal of Marketing, 37–52.

De Faria, P., Lima, F., & Santos, R. (2010). Cooperation in innovation activities: The importance of partners. Research Policy, 39(8), 1082–1092.

De Jong, J. P. J., & Freel, M. (2010). Absorptive capacity and the reach of collaboration in high technology small firms. Research Policy, 39(1), 47–54.

Dell'Era, C., & Verganti, R. (2010). Collaborative Strategies in Design-intensive Industries: Knowledge Diversity and Innovation. Long Range Planning, 43(1), 123–141.

Dittrich, K., & Duysters, G. (2007). Networking as a Means to Strategy Change: The Case of Open Innovation in Mobile Telephony. Journal of Product Innovation Management, 24(6), 510–521.

Dodgson, M., Gann, D., & Salter, A. (2006). The role of technology in the shift towards open innovation: the case of Procter & Gamble. R and D Management, 36(3), 333–346.

Donaldson, L. (2001). The Contingency Theory of Organizations (1st ed.). Thousand Oaks, CA: Sage Publications, INC.

Dosi, G. (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Research policy, 11(3), 147-162.

Dougherty, D. (1992). Interpretive barriers to successful product innovation in large firms. Organization Science, 3(2), 179-202.

Droge, C., Stanko, M. A., & Pollitte, W. A. (2010). Lead Users and Early Adopters on the Web: The Role of New Technology Product Blogs. Journal of Product Innovation Management, 27(1), 66–82.

Ebner, W., Leimeister, J. M., & Krcmar, H. (2009). Community engineering for innovations: the ideas competition as a method to nurture a virtual community for innovations. R&D Management, 39(4), 342–356.

Eisenhardt, K., & Tabrizi, B. (1995). Accelerating adaptive processes: Product innovation in the global computer industry. Administrative Science Quarterly.

Emden, Z., Calantone, R. J., & Droge, C. (2006). Collaborating for New Product Development: Selecting the Partner with Maximum Potential to Create Value. Journal of Product Innovation Management, 23(4), 330–341.

Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: ex-

ploring the phenomenon. R&d Management, 39(4), 311–316.

Ettlie, J. E., Bridges, W. P., & O'keefe, R. D. (1984). Organization strategy and structural differences for radical versus incremental innovation. Management science, 30(6), 682-695.

Fabrizio, K. R. (2009). Absorptive capacity and the search for innovation. Research Policy, 38(2), 255–267.

Faems, D., de Visser, M., Andries, P., & Looy, B. Van. (2010). Technology Alliance Portfolios and Financial Performance: Value-Enhancing and Cost-Increasing Effects of Open Innovation. Journal of Product Innovation Management, 27, 785–796.

Faems, D., Van Looy, B., & Debackere, K. (2005). Interorganizational collaboration and innovation: Toward a portfolio approach. Journal of Product Innovation Management, 22, 238–250.

Fleming, L., & Sorenson, O. (2001). Technology as a complex adaptive system: evidence from patent data. Research policy, 30(7), 1019-1039.

Foss, N. J., Laursen, K., & Pedersen, T. (2011). Linking Customer Interaction and Innovation: The Mediating Role of New Organizational Practices. Organization Science, 22(4), 980–999.

Freeman, C., & Soete, L. (1997). The economics of industrial innovation. Psychology Press.

Frenz, M., & Ietto-Gillies, G. (2009). The impact on innovation performance of different sources of knowledge: Evidence from the UK Community Innovation Survey. Research Policy, 38(7), 1125-1135.

Fritsch, M., & Meschede, M. (2001). Product Innovation, Process Innovation, and Size. Review of Industrial Organization, 19, 335–350.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. Journal of product innovation management, 19, 110-132.

Gassmann, O. (2006). Opening up the innovation process : towards an agenda. R&d Management, 223–228.

Gassmann, O., & Enkel, E. (2004, July). Towards a theory of open innovation: three core

process archetypes. In R&D management conference (Vol. 6, pp. 1-18).

Gassmann, O., Sandmeier, P., & Wecht, C. H. (2006). Extreme customer innovation in the front-end: learning from a new software paradigm. International Journal of Technology Management, 33(1), 46.

Gatignon, H., & Xuereb, J. (1997). Strategic orientation of the firm and new product performance. Journal of Marketing Research, XXXIV, 77–90.

Gemünden, H. G., Heydebreck, P., & Herden, R. (1992). Technological interweavement: a means of achieving innovation success. R&D Management, 22(4), 359-376.

Gemünden, H. G., Salomo, S., & Hölzle, K. (2007). Role Models for Radical Innovations in Times of Open Innovation. Creativity and Innovation Management, 16(4), 408–421.

Gnyawali, D. R., & Park, B.-J. (Robert). (2011). Co-opetition between giants: Collaboration with competitors for technological innovation. Research Policy, 40(5), 650–663.

Green, S. G., Gavin, M. B., & Aiman-Smith, L. (1995). Assessing a multidimensional measure of radical technological innovation. IEEE Transactions on Engineering Management, 42(3), 203–214.

Griffin, A., & Hauser, J. (1993). The voice of the Customer. Marketing Science, 12(1).

Griffin, A., & Page, A. L. (1996). PDMA success measurement project: recommended measures for product development success and failure. Journal of product innovation management, 13(6), 478-496.

Groen, A. J., & Linton, J. D. (2010). Is open innovation a field of study or a communication barrier to theory development?. Technovation, 30(11), 554.

Gupta, A. K., & Wilemon, D. (1998, October). Managing global product development teams. In Engineering and Technology Management, 1998. Pioneering New Technologies: Management Issues and Challenges in the Third Millennium. IEMC'98 Proceedings. International Conference on (pp. 328-333). IEEE.

Hagedoorn, J. (1993). Understanding the rationale of strategic technology partnering: interorganizational modes of cooperation and sectoral differences. Strategic Management Journal, 14(5), 371–385.

Hagedoorn, J. (2002). Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. Research policy, 31(4), 477-492.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate Data Analysis (7th ed.). Upper Saddle River: Pearson.

Han, J., Kim, N., & Srivastava, R. (1998). Market orientation and organizational performance: is innovation a missing link? Journal of Marketing, 62(4), 30–45.

Handfield, R., Ragatz, G., Petersen, K., & Monczka, R. M. (1999). Involving suppliers in new product development. California Management Review, 42(1).

Hauschildt, J., & Salomo, S. (2011). Innovationsmanagement. Vahlen.

Henard, D. H., & Szymanski, D. M. (2001). Why some new products are more successful than others. Journal of Marketing Research, 38(3), 362–375.

Herzog, P., & Leker, J. (2010). Open and closed innovation – different innovation cultures for different strategies. International Journal of Technology Management, 52(3/4), 322.

Hillebrand, B., & Biemans, W. G. (2004). Links between Internal and External Cooperation in Product Development: An Exploratory Study. Journal of Product Innovation Management, 21(2), 110–122.

Hippel, E. Von. (1994). "Sticky Information" and the Locus of problem Solving: Implications for Innovation. Management Science, 40(4), 429–439.

Hoaglin, D. C., & Iglewicz, B. (1987). Fine-tuning some resistant rules for outlier labeling. Journal of the American Statistical Association, 82(400), 1147-1149.

Hoaglin, D. C., Iglewicz, B., & Tukey, J. W. (1986). Performance of some resistant rules for outlier labeling. Journal of the American Statistical Association, 81(396), 991-999.

Holmes, S., & Smart, P. (2009). Exploring open innovation practice in firm-nonprofit engagements: a corporate social responsibility perspective. R&D Management, 39(4), 394–409.

Hoyer, W. D., Chandy, R., Dorotic, M., Krafft, M., & Singh, S. S. (2010). Consumer Cocreation in New Product Development. Journal of Service Research, 13(3), 283–296.

Hughes, B., & Wareham, J. (2010). Knowledge arbitrage in global pharma: a synthetic view of absorptive capacity and open innovation. R&D Management, 40(3), 324–343.

Hult, G. T. M., & Ferrell, O. C. (1997). A Global Learning Organization Structure and Market Information Processing. Jounal of Business Research, 40, 155–166.

Hultink, E. J., Talke, K., Griffin, A., & Veldhuizen, E. (2011). Market Information Processing

in New Product Development : The Importance of Process Interdependency and Data Quality. IEEE Transactions on Engineering Management, 58(2), 199–211.

Hunt, S. D., & Morgan, R. M. (1995). The Comparative Advantage Theory of Competition. Journal of Marketing, 59(April), 1–15.

Ili, S., Albers, A., & Miller, S. (2010). Open innovation in the automotive industry. R&D Management, 40(3), 246–255.

Im, S., & Workman, J. P. (2004). Market Orientation, Creativity, and New Product Performance in High Technology Firms. Journal of Marketing, 68(April), 114–132.

Jassawalla, A. R., & Sashittal, H. C. (1998). An examination of collaboration in high−technology new product development processes. Journal of product innovation management, 15(3), 237-254.

Jaworski, B. J., & Kohli, A. K. (1993). Market Orientation: Antecedents and Consequences. Journal of Marketing, 57(3), 53.

Jeppesen, L. B., & Frederiksen, L. (2006). Why Do Users Contribute to Firm-Hosted User Communities? The Case of Computer-Controlled Music Instruments. Organization Science, 17(1), 45–63.

Jeppesen, L. B., & Frederiksen, L. (2006). Why Do Users Contribute to Firm-Hosted User Communities? The Case of Computer-Controlled Music Instruments. Organization Science, 17(1), 45–63.

Jeppesen, L., & Lakhani, K. (2010). Marginality and Problem Solving Effectiveness in Broadcast Search. Organization Science, 21.

John, C. H. S., & Hall, E. H. (1991). The interdependency between marketing and manufacturing. Industrial Marketing Management, 20(3), 223-229.

Jordan, G., & Segelod, E. (2006). Software innovativeness: outcomes on project performance, knowledge enhancement, and external linkages. R and D Management, 36(2), 127–142.

Kaiser, H. F. (1974). An index of factorial simplicity. Psychometrika, 39(1), 31-36.

Katila, R., & Ahuja, G. (2002). Something Old , Something New : A Longitudinal Study of Search Behavior and New Product Introduction. Academy of Management Journal, 45(6), 1183–1194.

Katz, R., & Tushman, M. (1981). An investigation into the managerial roles and career paths of gatekeepers and project supervisors in a major R & D facility. R&D Management, 11(3), 103-110.

Kennedy, J. J. (1992). Analyzing qualitative data: Log-linear analysis for behavioral research . Praeger Publishers.

Keupp, M. M., & Gassmann, O. (2009). Determinants and archetype users of open innovation. R&D Management, 39(4), 331–341.

Kleinschmidt, E. J., & Cooper, R. G. (1991). The impact of product innovativeness on performance. Journal of product innovation management, 8(4), 240-251.

Knudsen, M. P. (2007). The relative importance of interfirm relationships and knowledge transfer for new product development success. Journal of Product Innovation Management, 24(2), 117-138.

Kock, A., Gemünden, H. G., Salomo, S., & Schultz, C. (2011). The Mixed Blessings of Technological Innovativeness for the Commercial Success of New Products. Journal of Product Innovation Management, 28(s1), 28–43.

Kohli, A. K., & Jaworski, B. J. (1990). Market Orientation: The Construct, Research Propositions, and Managerial Implications. Journal of Marketing, 54(April), 1–18.

Lakhani, K. R., & von Hippel, E. (2003). How open source software works: "free" user-to-user assistance. Research Policy, 32(6), 923–943.

Lambe, C. J., Spekman, R. E., & Hunt, S. D. (2002). Alliance Competence, Resources, and Alliance Success: Conceptualization, Measurement, and Initial Test. Journal of the Academy of Marketing Science, 30(2), 141–158.

Lancaster, G. (1993). Marketing and engineering: can there ever be synergy?. Journal of Marketing Management, 9(2), 141-153.

Lau, A. K. W., Tang, E., & Yam, R. C. M. (2010). Effects of Supplier and Customer Integration on Product Innovation and Performance: Empirical Evidence in Hong Kong Manufacturers. Journal of Product Innovation Management, 27(5), 761–777.

Laursen, K., & Salter, A. (2004). Searching high and low: what types of firms use universities as a source of innovation? Research Policy, 33(8), 1201–1215.

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining

innovation performance among U.K. manufacturing firms. Strategic Management Journal, 27(2), 131–150.

Lawrence, P. R., & Lorsch, J. W. (1967). Differentiation and integration in complex organizations. Administrative science quarterly, 1-47.

Lee, S., Park, G., Yoon, B., & Park, J. (2010). Open innovation in SMEs—An intermediated network model. Research Policy, 39(2), 290–300.

Lee, Y., & Colarelli O'Connor, G. (2003). The impact of communication strategy on launching new products: The moderating role of product innovativeness. Journal of Product Innovation Management, 20(1), 4-21.

Leifer, R. (2000). Radical innovation: How mature companies can outsmart upstarts. Harvard Business Press.

Leonard-Barton, D. (1993). Core capabilities and core rigidities: A paradox in managing new product development. Long Range Planning.

Leonard-Barton, D. (1995). Wellspring of knowledge. Harvard Business School Press, Boston, MA.

Leonard, D., & Rayport, J. (1997). Spark innovation through empathic design. Harvard Business Review, 102–113.

Li, T., & Calantone, R. J. (1998). The impact of market knowledge competence on new product advantage: conceptualization and empirical examination. The Journal of Marketing, 62(October), 13–29.

Li, Y., & Vanhaverbeke, W. (2009). The effects of inter-industry and country difference in supplier relationships on pioneering innovations. Technovation, 29(12), 843–858.

Li, Y., Vanhaverbeke, W., & Schoenmakers, W. (2008). Exploration and Exploitation in Innovation: Reframing the Interpretation. Creativity and Innovation Management, 17(2), 107–126.

Link, A. N., & Rees, J. (1990). Firm size, university based research, and the returns to R&D. Small Business Economics, 2(1), 25–31.

Lynn, G. S., Reilly, R. R., & Akgün, A. E. (2000). Knowledge management in new product teams: practices and outcomes. Engineering Management, IEEE Transactions on, 47(2), 221-231.

Maltz, E., & Kohli, A. K. (1996). Market Intelligence Dissemination across Functional Boundaries. Journal of Marketing Research, 33(1), 47.

March, J. G. (1991). Exploration and exploitation in organizational learning. Organization science, 2(1), 71-87.

Marquardt, D. W. (1970). Generalized inverses, ridge regression, biased linear estimation, and nonlinear estimation. Technometrics, 12, 591–256.

McDermott, C. M., & O'Connor, G. C. (2002). Managing radical innovation: an overview od emergent strategy issues. Journal of Product Innovation Management, 19, 424–438.

McQuarrie, E. F. (2014). Customer visits: Building a better market focus. Routledge.

Melander, L., & Tell, F. (2014). Uncertainty in collaborative NPD : Effects on the selection of technology and supplier. Journal of Engineering and Technology Management, 31, 103–119.

Milliken, F. J., & Martins, L. L. (1996). Searching for Common Threads: Understanding the Multiple Effects of Diversity in Organizational Groups. The Academy of Management Review, 21(2), 402.

Miotti, L., & Sachwald, F. (2003). Co-operative R&D: Why and with whom? An integrated framework of analysis. Research Policy, 32, 1481–1499.

Molina-Castillo, F. J., & Munuera-Aleman, J. L. (2009). The joint impact of quality and innovativeness on short-term new product performance. Industrial Marketing Management, 38(8), 984–993.

Moorman, C. (1995). Market Organizational Processes: Product Cultural Outcomes Information Antecedents and. Journal of Marketing Research, 32(3), 318–335.

Morgan, N. A., Vorhies, D. W., & Mason, C. H. (2009). Market Orientation, Marketing Capabilities, And Firm Performance. Strategic Management Journal, 920(January), 909–920.

Morrison, P. D., Roberts, J. H., & Midgley, D. F. (2004). The nature of lead users and measurement of leading edge status. Research Policy, 33(2), 351–362.

Mortara, L., Thomson, R., Moore, C., Armara, K., Kerr, C., Phaal, R., & Probert, D. (2010). Developing a technology intelligence strategy at kodak european research: Scan & target. Research Technology Management, 53(4), 27 – 38.

Mowery, D. C. (2009). Plus ca change: Industrial R&D in the "third industrial

revolution". Industrial and corporate change, dtn049.

Murray, F., & O'Mahony, S. (2007). Exploring the foundations of cumulative innovation: Implications for organization science. Organization Science, 18(6), 1006-1021.

Narver, J. C., & Slater, S. F. (1990). The effect of a market orientation on business profitability. The Journal of Marketing, (October), 20–35.

Narver, J. C., Slater, S. F., & Maclachlan, D. L. (2004). Responsive and Proactive Market Orientation and New-Product Success. Journal of Product Innovation Management, (1990), 334–347.

Nelson, R. R., & Winter, S. G. (1982). The Schumpeterian tradeoff revisited. The American Economic Review, 114-132.

Nerkar, A. (2003). Old is gold? The value of temporal exploration in the creation of new knowledge. Management Science, 49(2), 211-229.

Neter, J., Wasserman, W., & Kutner, M. H. (1989). Applied linear regression models.

Nicholls-Nixon, C. L., & Woo, C. Y. (2003). Technology sourcing and output of established firms in a regime of encompassing technological change. Strategic Management Journal, 24(7), 651–666.

Nieto, M. J., & Santamaría, L. (2007). The importance of diverse collaborative networks for the novelty of product innovation. Technovation, 27(6-7), 367–377.

Nonaka, I., & Takeuchi, H. (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation. Oxford university press.

Nuvolari, A. (2004). Collective invention during the British Industrial Revolution: the case of the Cornish pumping engine. Cambridge Journal of Economics, 347-363.

O'Connor, G. C. (1998). Market learning and radical innovation: A cross case comparison of eight radical innovation projects. Journal of product innovation management, 15(2), 151-166.

Ogawa, S. (1998). Does sticky information affect the locus of innovation? Evidence from the Japanese convenience-store industry. Research Policy, 26(7-8), 777–790.

Ottum, B. D., & Moore, W. L. (1997). The Role of Market Information in New Product Success/Failure. Journal of Product Innovation Management, 14, 258–273.

Pallant, J. (2010). SPSS survival manual (4th ed.). New York: McGraw Hill.

Pennings, J. M. (1992). Structural contingency theory-a reappraisal. Research in organizational behavior, 14, 267-309.

Peteraf, M. (1993). The cornerstones of competitive advantage: A resource‐based view. Strategic Management Journal, 14, 179–191.

Petersen, K. J., Handfield, R. B., & Ragatz, G. L. (2003). A Model of Supplier Integration into New Product Development. Journal of Product Innovation Management, 20(4), 284–299.

Petersen, K., Handfield, R., & Ragatz, G. (2005). Supplier integration into new product development: coordinating product, process and supply chain design. Journal of Operations Management, 23, 371–388.

Piller, F. T., & Walcher, D. (2006). Toolkits for idea competitions: a novel method to integrate users in new product development. R&D Management, 36(3), 307–318.

Piller, F., & West, J. (2014). Firms, Users, and Innovation: An Interactive Model of Coupled Open Innovation. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), New Frontiers in Open Innovation (1st ed.). Oxford: Oxford University Press.

Poetz, M. K., & Schreier, M. (2012). The Value of Crowdsourcing: Can Users Really Compete with Professionals in Generating New Product Ideas? Journal of Product Innovation Management, 29(2), 245–256.

Prahalad, C. K., & Ramaswamy, V. (2000). Co-opting customer competence. Harvard business review, 78(1), 79-90.

Redding, W. C. (1972). Communication within the organization: An interpretive review of theory and research. Industrial Communication Council.

Ritala, P., & Hurmelinna-Laukkanen, P. (2013). Incremental and Radical Innovation in Coopetition-The Role of Absorptive Capacity and Appropriability. Journal of Product Innovation Management, 30(1), 154–169.

Rochford, L., & Rudelius, W. (1992). How involving more functional areas within a firm affects the new product process. Journal of Product Innovation Management, 9(4), 287-299.

Rogers, E. M. (2010). Diffusion of innovations. Simon and Schuster.

Rothaermel, F., & Alexandre, M. (2009). Ambidexterity in technology sourcing: The mod-

erating role of absorptive capacity. Organization Science, 20(4), 759–780.

Rothaermel, F., & Hess, A. (2007). Building dynamic capabilities: Innovation driven by individual-, firm-, and network-level effects. Organization Science, 18(6), 898–921.

Schiele, H. (2010). Early supplier integration: the dual role of purchasing in new product development. R&D Management, 40(2), 138–153.

Schultz, C., Salomo, S., de Brentani, U., & Kleinschmidt, E. J. (2013). How Formal Control Influences Decision-Making Clarity and Innovation Performance. Journal of Product Innovation Management, 30(3), 430–447.

Sieg, J. H., Wallin, M. W., & von Krogh, G. (2010). Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry. R&D Management, 281–291.

Sinkula, J. M. (1994). Market Information and Processing Organizational Learning. Journal of Marketing, 58(1), 35–45.

Slater, S. F., & Narver, J. C. (2000). The Positive Effect of a Market Orientation on Business Profitability: A Balanced Replication. Journal of Business Research, 48, 69–73.

Slowinski, G., & Sagal, M. W. (2010). Good practices in open innovation. Research Technology Management, 53(5), 38 – 45.

Smits, A., & Kok, R. (2012). The interplay between outbound team strategy and market information processing in the course of "really new" NPD projects. Industrial Marketing Management, 41(5), 759–769.

Song, M., & Di Benedetto, C. A. (2008). Supplier's involvement and success of radical new product development in new ventures. Journal of Operations Management, 26(1), 1–22.

Song, X. M., & Montoya-Weiss, M. M. (1998). Critical Development Activites for Really New Versus Incremental Products. Journal of Product Innovation Management.

Sood, A., & Tellis, G. J. (2005). Technological evolution and radical innovation. Journal of Marketing, 69(3), 152-168.

Souder, W. E. (1988). Managing relations between R&D and marketing in new product development projects. Journal of product innovation management, 5(1), 6-19.

Souder, W. E., & Song, X. M. (1997). Contingent product design and marketing strategies influencing new project sucess and failure in U.S. and Japanese Electronic firm. Journal

of Product Innovation Management.

Spithoven, A., Clarysse, B., & Knockaert, M. (2011). Building absorptive capacity to organise inbound open innovation in traditional industries. Technovation, 31(1), 10–21.

Stam, W. (2009). When does community participation enhance the performance of open source software companies? Research Policy, 38(8), 1288–1299.

Su, Z., Ahlstrom, D., Li, J., & Cheng, D. (2013). Knowledge creation capability, absorptive capacity, and product innovativeness. R&D Management, 43(5), 473–485.

Szymanski, D. M., Kroff, M. W., & Troy, L. C. (2007). Innovativeness and new product success: insights from the cumulative evidence. Journal of the Academy of Marketing Science, 35(1), 35-52.

Tabachnick, B. G., & Fidell, L. S. (2007). Multilevel linear modeling. Using multivariate statistics, 781-857.

Tatikonda, M. V., & Montoya-Weiss, M. M. (2001). Integrating operations and marketing perspectives of product innovation: The influence of organizational process factors and capabilities on development performance. Management Science, 47(1), 151-172.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. Research Policy, 15(February), 285–305.

Teece, D. J. (2010). Business Models, Business Strategy and Innovation. Long Range Planning, 43(2-3), 172–194.

Terwiesch, C., & Xu, Y. (2008). Innovation Contests, Open Innovation, and Multiagent Problem Solving. Management Science, 54(9), 1529–1543.

Tether, B. (2002). Who co-operates for innovation, andwhy. An empirical analysis. Research Policy, 31, 947–967.

Tidd, J., & Bessant, J. (2009). Managing innovation. 4th edition.

Trochim, W., & Donnelly, J. (2008). Research Methods Knowledge Base (3rd ed.). Mason, OH.: Cengage Learning.

Trott, P., & Hartmann, D. A. P. (2009). Why'open innovation'is old wine in new bottles. International Journal of Innovation Management, 13(04), 715-736.

Tukey, J. W. (1977). Exploratory Data Analysis. Addison-Wesley. Reading.

Tushman, M. L., & Nadler, D. A. (1978). Information Processing as an Integrating Concept

in Organizational Design. The Academy of Management Review, 3(3), 613.

Tushman, M., Lakhani, K. R., & Lifshitz-Assaf, H. (2012). Open Innovation and Organizational Design. Journal of Organization Design, 1(1), 24–27. doi:10.7146/jod.2012.1.8

Un, C. A., Cuervo-Cazurra, A., & Asakawa, K. (2010). R&D Collaborations and Product Innovation. Journal of Product Innovation Management, 27(5), 673–689.

Urban, G. L., & von Hippel, E. (1988). Lead User Analyses for the Development of New Industrial Products. Management Science, 34(5), 569–582.

Van de Vrande, V., de Jong, J. P. J., Vanhaverbeke, W., & de Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. Technovation, 29(6-7), 423–437.

Veldhuizen, E., Hultink, E. J., & Griffin, A. (2006). Modeling market information processing in new product development: An empirical analysis. Journal of Engineering and Technology Management, 23(4), 353–373.

Veugelers, R. (1997). Internal R&D expenditures and external technology sourcing. Research Policy, 26(3), 303 – 315.

Von Hippel, E. (1986). Lead Users: A Source of Novel Product Concepts. Management Science, 32(7), 791–805.

Von Hippel, E. (2009). Democratizing Innovation: The Evolving Phenomenon of User Innovation. International Journal of Innovation Science, 1(1), 29–40.

Weerd-Nederhof, P. De, & Fisscher, O. (2003). Alignment and Alliances for Research Institutes Engaged in Product Innovation. Two Case Studies. Creativity & Innovation Management, 12(2), 65–75.

West, J. (2014). Challenges of Funding Open Innovation Platforms : Lessons from Symbian Ltd. In W. V. and J. W. Henry Chesbrough (Ed.), New Frontiers in Open Innovaion (1st ed., pp. 1–38). Oxford: Oxford University Press.

West, J., & Bogers, M. (2013). Leveraging External Sources of Innovation: A Review of Research on Open Innovation. Journal of Product Innovation Management, 31(4), 1–18.

West, J., & Gallagher, S. (2006). Challenges of open innovation: the paradox of firm investment in open-source software. R&D Management, 36(3), 319–331.

Whelan, E., Teigland, R., Donnellan, B., & Golden, W. (2010). How Internet technologies im-

pact information flows in R&D: reconsidering the technological gatekeeper. R&D Management, 40(4), 400–413.

Woolridge, J. M. (2009). Introductory Econometrics: A Modern Approach 4e Thomson. South-Western: Mason, Ohio.

Wu, L.-Y. (2010). Applicability of the resource-based and dynamic-capability views under environmental volatility. Journal of Business Research, 63(1), 27–31.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. Academy of management review, 27(2), 185-203.

Zeng, S. X., Xie, X. M., & Tam, C. M. (2010). Relationship between cooperation networks and innovation performance of SMEs. Technovation, 30(3), 181–194.

Zhou, K. Z., Chi Kin Yim, & Tse, D. K. (2005). The Effects of Strategic Orientations on Technology- and Market-Based Breakthrough innovations. Journal of Marketing, 69(April), 42–60.

Appendix

Conference Papers

The following is list represents the conference articles what were submitted, accepted and presented in the course of doing this study.

The problem of internal information dissemination from external collaborations in radical NPD projects.

-By Ph.D. candidate Thomas Tandrup, prof. Carsten Schultz, and prof. Søren Salomo.

In the past decade, the issue of customer integration into firms innovation process has become an important component in new product development (NPD) research. Research has focused on aspects related to firms reliance on the acquisition and processing of market information guiding new NPD efforts (Hultink, Talke, Griffin, & Veldhuizen, 2011; Jaworski & Kohli, 1993; Narver, Slater, & Maclachlan, 2004) to integrated collaboration efforts with entities outside the firm (Chesbrough & Appleyard, 2007; Cohen & Levinthal, 1990; Spithoven, Clarysse, & Knockaert, 2011; von Hippel, 2009). However, within this growing area of research little attention has been given to the impact of different types of customer interaction (Sandmeier, 2003) or specifically, how they affect NPD performance when they are applied within the same firm. We hypotheses that firms who engage in collaboration with external partners are also more likely to make use of market information processing.

- **21st International Product Development Management Conference (IPDMC) -- 2014.**
- **25th International Society for Professional Innovation Management Conference (ISPIM) -- 2014**

How firms internalize information from external collaborators in NPD: A contingency approach to understanding Open Innovation.

By Ph.D. candidate Thomas Tandrup.

The majority of research into the areas of external collaboration has looked at the bene-

fits of including external sources for innovation into the NPD process. External collaborators can then be said to mitigate the uncertainty involved with new products by providing the firm with knowledge and information that makes the NPD more market relevant (Gassmann, Sandmeier, & Wecht, 2006; von Hippel, 2009). However, research into customers as sources for innovation has been divided on their value in promoting very innovative new products (Hamel & Prahalad, 1993; Sandmeier, 2009), and similar discussions are prevailing within research into suppliers as collaborators (Eisenhardt & Tabrizi, 1995; Melander & Tell, 2014; Petersen, Handfield, & Ragatz, 2005). Both of these areas of research have shown mixed result depending on the level of innovativeness and the extent of integration of external collaborators in the NPD project. This indicates that while external collaboration can improve NPD performance it might also prove a hindrance depending on the level of innovativeness involved in the NPD project. The more innovative the NPD project, the more challenging it is to gather relevant market information and disseminate it internally (Carlile, 2002). To the best of out knowledge, little attention has been given to the information processing capabilities needed to identify, acquire and disseminate information from external collaborators.

- **The R&D Management Conference (RADMA) -- 2015**

The development of the conference papers and feedback from the conference participants was instrumental in the development of this study.

Complete Sample of External Collaboration studies Reviewed

External Collaboration Literature

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Afuah, A., and C. L. Tucci.	Crowdsourcing as a solution to distant search	2012	Academy of Management Review 37	Crowdsourcing as a tool for searching a product landscape. It is argued that crowdsourcing extents the area of the landscape that can be searched.	Qualitative analysis	Firm-level	Non-applicable		In certain circumstances crowdsourcing transforms distant search into local search, thereby enabling firms to take advantage of the many benefits of distant search without having to endure many of its costs. Thus, crowdsourcing may be a better mechanism for solving some problems than internal sourcing or designated contracting.	Conceptual
Ahuja, G,	Collaboration networks, structural holes, and innovation: A longitudial study	2000	Administrative Science Quarterly 45	To asses the effects of a firms' network of relations on innovation, This paper elaborates a theoretical framework that relates three aspects of a firm's ego network - direct ties, indirect ties, and structural holes (disconnections between a firm's partners) - to the firms subsequent innovation output.	Quantitative Analysis	Firm-level	Direct and indirect ties	Patents	Direct and indirect ties has a positive impact on innovation, but in the inter-firm collaboration structural holes impacts innovation negatively.	97 international chemical firms
Almirall, E., and R. Casadesus-Masanell	Open versus closed innovation: A model of discovery and divergence	2010	Academy of Management Review 35	How open innovation allows firms to discover new product features that would otherwise be challenging to envision under a closed approach to innovation.	Quantitative Analysis	Industry-level	Non-applicable		when partners have divergent goals, open innovation restricts the firm's ability to establish the product's technological trajectory. The resolution of the trade-off between benefits of discovery and costs of divergence determines the best approach to innovation	Simulation data. N = 16
Arora, A., A. Fosfuri, and A. Gambardella	Markets for technology and their implications for corporate strategy	2001	Industrial and Corporate Change 10	Markets for technology increase the strategic space for firms. Firms can choose to license instead of developing, or they can develop it and license it out. This has implications for IP management, which must take a more open approach,	Qualitative analysis	Firm-level & Industry-level	Non-applicable		Outbound technology licensing from large technology-based firms mostly to smaller firms in distant high competitive markets who has small market shares. The increase in inbound inno results in higher "penalties" if firms have rigidities or opposition to innovation. Increase the need for downstream differentiation. At an industry level markets for technology lower entry barriers, increase competition and compress product life cycles.	Patent data
Aylen, J.	Open versus closed innovation: Development of the wide strip mill for steel in the United States during the 1920s	2010	R&D Management 40	Comparison of steel mill innovation. One firm used secrecy and one team used collaboration in their R&D efforts.	Qualitative analysis	Firm-level	Level of outside influence	Global sales & Dominant Design	Breakthroughs came from the open approach.	Case study
Baldwin, C.Y., and E. von Hippel	Modeling a paradigm shift: From producer innovation to user and open collaborative innovation.	2011	Organization Science 22	Addresses user vs. open innovation models. Design, architecture and communication costs analysed for each model.	Qualitative analysis	Firm-level	Non-applicable, compares cost structures		Users and collaborative open models often superior to the closed model of innovation.	Conceptual
Barge-Gil, A.	Cooperation-based innovators and peripheral cooperators: An empirical analysis of their characteristics and behavior.	2010	Technovation 30	What characterizes firms that use cooperation as their main way to innovate.	Quantitative Analysis	Firm-level	Innovation process & Cooperation behaviour	Cooperation with different external sources	Smaller firms and firms outside the high-tech sectors are more likely to be cooperation-based innovators. The type of cooperative behaviour matters. Cooperation with providers, with a few agents and with national partners are strong features of cooperation-based innovators.	1624 spanish firm
Bartl, M. Füller, J. Mühlbacher, H. and Ernst, H.	A Manager's Perspective on Virtual Customer Integration for New Product Development	2012	Journal of Product Innovation Management 29	Despite the high potential of virtual customer integration (VCI) methods for new product development (NPD) mentioned in the literature, practical use is still limited. This paper aims to provide a deeper understanding of managers' perspectives on VCI and their intentions to use these methods for NPD.	Qualitative analysis	Firm-level	Advantages, Disadvantages, subjective norms, Perceived behaviour control	Behaviour intention to implement VCI	Managers show high interest in virtually integrating customers in NPD processes. Managers consider identification of future customer needs, a broader decision basis, increased efficiency in gathering and use of customer information, and increased customer retention as major advantages of VCI. Disadvantages considered by managers in making their overall judgment are the lack of secrecy and only incremental innovations.	216 respondents
Belderbos, Carree, Lokshin	Complementarity in R & D Cooperation Strategies	2006	Review of Industrial Organization 28	Engagement in R&D collaboration.	Quantitative Analysis	Firm-level	Competitor, supplier, customer University cooperation; Spillovers; R&d intensity; investment group; Firm size.	Labor productivity.	Benefits of collaboration depends firms size and strategy. Collaboration with customers enhances market acceptance and competitor and university collaboration. Small firms lower effect due to high cost and complexity of multiple collaborators.	1992 firms form Netherlands community innovation survey (CIS).
Belderbos, R., D. Faems, B. Leten, and B. van Looy.	Technological activities and their impact on the financial performance of the firm: Exploitation and exploration within and between firms	2010	Journal of Product Innovation Management 27	Analyzes the impact of firms' technological strategies on their financial performance. Technology strategies are defined by making a distinction between explorative and exploitative as well as collaborative and solitary technological activities	Quantitative Analysis	Firm-level	Technological & collaboration activities	Financial Performance	Firms engaging more intensively in collaboration perform relatively stronger in explorative activities. At the same time, a negative relationship is observed between the share of collaborative technological activities and a firm's market value. This negative relationship is most pronounced in collaborative activities of an exploratory nature.	168 R&D teams from Japan, US and Europe

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Belussi, F., A. Sammarra, and S. R. Sedita.	Learning at the boundaries in an "Open Regional Innovation System": A focus on firms' innovation strategies in the Emilia Romagna life science industry.	2010	Research Policy 39	Focuses on the ORIS model, which is an open regional innovation system. This makes firm's overcome the boundaries of the firm and the region.	Quantitative Analysis	Firm-Level	R&D expenditure, Sectors	Patents	Innovation performance is significantly effected, positively, by their openness.	78 life science firms
Benassi, M., and A. Di Minin.	Playing in between: Patent brokers in markets for technology.	2009	R&D Management 39	patent brokers do not only stay in between supply and demand of innovation, but play in between executing complex transactions and taking entrepreneurial risk. In doing so, they serve a support function to R&D managers of firms adopting various approaches to technological change.	Qualitative analysis	Firm-level	Non-applicable		Even in very dense environments, the bridging role of intellectual property intermediaries is that of market makers, who leverage their specific investment to play in between technology demand and supply.	15 US intermediaries
Bercovitz, J. E. L., and M. P. Feldman.	Fishing upstream: Firm innovation strategy and university research alliances.	2007	Research Policy 36	The influence of innovation strategy and university-based research.	Quantitative Analysis	Firm-level	Different exploration types, R&D structure, Decision making	University-based exploration and mode of interaction	Firms with R&D strategies weighted towards exploratory activities allocate a greater share of their R&D recourses to exploratory university research. Also when the potential for IP conflicts exists firms tend to prefer University collaboration above other types.	45
Bogers, M., and J. West.	Managing distributed innovation: Strategic utilization of open and user innovation.	2012	Creativity and Innovation Man- agement 21	Provides a framework for looking at distributes modes of innovation.	Qualitative analysis	Conceptual	Non-applicable		The framework for the strategic management of distributed innovation. Firms engage in distributed innovation face 3 challenges. 1. identifying a supply of external innovation. 2. making sure the flow of innovations continue. 3. finding a way to appropriate the innovations. Overall, the different perspectives of distributed innovation belongs to the same family but cannot be unified under a single theory.	Conceptual
Bogers, M., and S. Lhuillery.	A functional perspective on learning and innovation: Investigating the organization of absorptive capacity.	2011	Industry and Innovation 18	Examines the firm level characteristics that effects the firm absorptive capacity, such as R&D, manufacturing and marketing.	Quantitative Analysis	Firm-level	Type of collaborator	Product, process and both innovation	Absorptive capacity is significantly different if the knowledge is R&D based or non-R&D based. R&D is important for product collaboration with research institutions. manufacturing is important for product collaboration with suppliers and competitors. marketing helps absorb knowledge for both product and process innovation and product innovations with competitors.	659 Swiss firms
Bonaccorsi, A. and Lipparini, A.	Strategic Partnerships in New Product Development: an Italian Case Study	1994	Journal of Product Innovation Management 11	This article provides some revealing insights into what a leading Italian firm operating in markets where innovation is a focal point of competition has learned about partnering with suppliers in the new products development process. To succeed in a rapidly changing environment, the firm promoted and sustained tightly linked, integrated supplier relationships. This provided one key element of a shorter product cycle, led to better products, and increased the firm's ability to compete.	Qualitative analysis	Firm-level	Non-applicable		Some firms succeed and others fail in new product development. The early involvement of suppliers in the innovative process is one of the main aspects that contributes to a company's performance. The increasing dependency of most companies on an expanding base of suppliers makes the management of these relationships of great importance. To be effective, such relationships should be changed from the traditional arm's length purchasing agreement to integrated part-nerships. When the supplier of a critical component is not a close partner in the design process, the product can experience major schedule problems and lower quality. These problems are further complicated if the supplier is relying on others for the purchase of parts to be incorporated in its product.	Single case study of italian firm
Boudreau, K.	Open platform strategies and innovation: Granting access vs. devolving control.	2010	Management Science 56	This paper studies two fundamentally distinct approaches to opening a technology platform and their different impacts on innovation. One approach is to grant access to a platform and thereby open up markets for complementary components around the platform. Another approach is to give up control over the platform itself.	Quantitative Analysis	Industry-level	Platform strategies & Openness characteristics	Number of new devices	Granting greater levels of access to independent hardware developer firms produces up to a fivefold acceleration in the rate of new handheld device development, depending on the precise degree of access and how this policy was implemented. Where operating system platform owners went further to give up control (beyond just granting access to their platforms) the incremental effect on new device development was still positive .	1706 observations (panel data from 21 hand-held systems)

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Brettel, M. Cleven, N.	Innovation Culture, Collaboration with External Partners and NPD Performance	2011	Creativity and Innovation Management 20	Researchers and managers have found that the use of external knowledge in the process of new product development (NPD) helps to sustain a firm's competitiveness by strengthening its innovative performance. However, little is known about why some firms use external knowledge sources for NPD in an extensive manner while others hardly ever use them. In addition, there is disagreement about which external partners significantly contribute to the innovative performance of a firm as valuable knowledge sources. Based	Quantitative Analysis	Firm-level	Innovation Culture, Collaboration with difference actors,	NPD performance	results indicate that a firm's orientation towards technological innovation has a significant and positive relationship to a firm's collaborative activities with customers, universities and independent experts. This result sug-gests that these external partners are important sources of knowledge for firms that consider technological innovation a strategically important task and that want to keep up with new technological trends by inventing and refining superior products. Collaboration with customers may help firms determine which kinds of technologies are needed for future innovations, and collaboration with universities may allow firms to keep up to date with the latest technological developments. For their part, independent experts such as engineering offices and independent research institutes may help firms to conceptualize and implement certain innovative product ideas. Although suppliers are discussed in the literature as important sources of knowledge for product design, quality improvement, improved cycle time and cost reduction.	254 German firms
Bruneel, J. D'Este, P. and Salter, A.	Investigating the factors that diminish the barriers to university–industry collaboration	2010	Research Policy 39	Although the literature on university–industry links has begun to uncover the reasons for, and types of, collaboration between universities and businesses, it offers relatively little explanation of ways to reduce the barriers in these collaborations. This paper seeks to unpack the nature of the obstacles to collaborations between universities and industry, exploring influence of different mechanisms in lowering barriers related to the orientation of universities and to the transactions involved in working with university partners.	Quantitative Analysis	Firm-level	Collaboration experience, Breadth of interaction, Inter-organizational trust	Orientation and transaction related barriers	The analysis shows that prior experience of collaborative research lowers orientation- related barriers and that greater levels of trust reduce both types of barriers studied. It also indicates that breadth of interaction diminishes the orientation-related, but increases transaction-related barriers.	44 organizations
Callahan, J. and Lasry, E.	The importance of customer input in the development of very new products	2004	R&D Management 34	This research explores the acquisition of customer input and its importance in the development of very new products.	Quantitative analysis	Firm-level	Overall Newness, Market Newness, Technology Newness	End-user input	found that the importance of customer input increases with market newness of a product up to a point and then drops off for very new products, whereas the importance of customer input increases with technological newness of a product without dropping off. They also found that the importance of customer input significantly increases the use of customer intensive market research methods; whereas, neither market nor technological product newness in themselves had much direct effect on research methods.	55 NPD projects Computer industry
Cassiman, B., M. C. Di Guardo, and G. Valentini.	Organizing links with science: Cooperate or contract? A project-level analysis.	2010	Research Policy 39	Examines how firm-university level collaboration works on the individual project level.	Quantitative Analysis	Project-level	Project cost, Basicness, Strategic importance, Codifiability.	Cooperate, or contract with university. Cooperate with firms.	basic projects are likely to be developed through formal cooperative agreements with universities. Such projects also tend to be strategically less important. For strategically more important projects, in contrast, and for those where the knowledge to be developed is particularly novel to the firm, the firm is more likely to resort to formal contracting with a university for a specific component of the R&D project, usually early on in the project	52 R&D projects
Ceccagnoli, M., S. J. H. Graham, M. J. Higgins, and J. Lee.	Productivity and the role of complementary assets in firms' demand for technology innovations.	2010	Industrial and Corporate Change 19	This article uses data on transactions in the pharmaceutical industry to examine the drivers of external technology acquisition strategies of profit-seeking corporations.	Quantitative Analysis	Firm-Level	Productivity, Co-specialized assets.	Patent attached to NDA is not owned by NDA applicant	findings suggest that firms possessing cospecialized complementary assets and stronger R&D productivity are less likely to source technologies developed outside the firm as inputs into their new products. For firms that hold comparatively high levels of cospecialized com- plementary assets, the presence of relatively poor internal R&D productivity tends to increase the firm's propensity to acquire technology in the external market.	Patent data
Chesbrough, H.	The era of open innovation.	2003	MIT Sloan Management Review 44	Identifies changes in the traditional, closed model of innovation where firms develop new products and processes internally. Claims the foundation for this model is crumbling in the current economic environment.	Qualitative analysis	Conceptual	Non-applicable		Identifies several principles for open innovation that validates the concept. 1. Not all the smart people work for the firm. 2. External R&D create significant value, with internal R&D need to capture value. 3. Don't have to originate research to profit from it. 4. Better business models more important than reaching market first. 5. Internal and external ideas important to profit. 6. IP can be licensed for profit and acquired to advance the business.	Conceptual

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Chesbrough, H. and Appleyard, M.	Open Innovation and Strategy	2007	California Management Review	Open strategy balances the tenets of traditional business strategy with the promise of open innovation. It embraces the benefits of openness as a means of expanding value creation for organizations. It places certain limits on traditional business models when those limits are necessary to foster greater adoption of an innovation approach. Open strategy also introduces new business models based on invention and coordination undertaken within a community of innovators. At the same time, though, open strategy is realistic about the need to sustain open innovation approaches over time.	Conceptual	Firm-level	Non-applicable		Open strategy balances the powerful value creation forces that can be found in creative individuals, innovation communities, and collaborative initiatives with the need to capture value in order to sustain continued participation and support of those initiatives. Traditional concepts of business strategy either underestimate the value of open invention and open coordination, or they ignore them outright.	Conceptual
Chesbrough, H., and A. K. Crowther.	Beyond high tech: Early adopters of open innovation in other industries.	2006	R&D Management 36	Takes the open innovation concept away from high tech industries, which was the focus of the initial open innovation research and tests it against firms in industries which are not high tech.	Qualitative analysis	Firm-Level	Non-applicable		Find that open innovation also applies outside high-tech industries and that open innovation is not just outsourcing of internal R&D.	12 firms
Chesbrough, H., and R. S. Rosenbloom.	The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies.	2002	Industrial and Corporate Change 11	This paper explores the role of the business model in capturing value from early stage technology. A successful business model creates a heuristic logic that connects technical potential with the realization of economic value. The business model unlocks latent value from a technology, but its logic constrains the subsequent search for new, alternative models for other technologies later on	Qualitative analysis	Firm-level	Non-applicable		The ultimate role of the business model for an innovation is to ensure that the technological core of the innovation delivers value to the customer. Because discovery- oriented research often produces spillover technologies that lack a clear path to market, discovering a viable business model for these spillovers is a critical and neglected dimension of creating value from technology.	1 US firm (Xerox and spin-offs.)
Chiaroni, D., V. Chiesa, and F. Frattini.	Unravelling the process from closed to open innovation: Evidence from mature, asset-intensive industries.	2010	R&D Management 40	Addresses the organizational change that is needed to go from a closed innovation model to an open model. What organizational and management structures?	Qualitative analysis	Firm-level	Non-applicable		The results show that the journey from Closed to Open Innovation involves four main dimensions of the firm's organization, i.e. inter-organizational networks, organizational structures, evaluation processes and knowledge management systems, along which change could be managed and stimulated.	4 Italian firms
Christensen, J. F., M. H. Olesen, and J. S. Kjær.	The industrial dynamics of open innovation: Evidence from the transformation of consumer electronics.	2005	Research Policy 34	The main proposition of the paper is that the specific modes in which different companies manage Open Innovation in regard to an emerging technology reflect their differential position within the innovation system in question, the nature and stage of maturity of the technological regime, and the particular value proposition pursued by companies.	Qualitative analysis	Firm-level	Non-applicable		Most successful innovation strategies entail not only firm-specific inputs of technical and managerial skills, a good analysis of the innovative opportunities and the competitive and cooperative context and an entrepreneurial vision. Successful strategies also entail the abilities or luck to exploit more or less coincidental opportunities emerging outside the boundaries of the firm	5 international and Danish firms.
Chuma, H.	Increasing complexity and limits of organization in the microlithography industry: Implications for science-based industries.	2006	Research Policy 35	The purpose of this paper is to clarify how science-based industries with a high clockspeed become required to respond to their rapidly advancing complexity and what kinds of new organizational forms are inevitable to cope with such complexity beyond conventional vertically integrated ones. The	Quantitative Analysis	Industry-level	Shipments, lag	Product (Time series)	the organizational form of such a complex is itself thoroughly contemporary in that the corporate boundaries are quite flexible and porous so as effectively to orchestrate dispersal of specialized knowledge and knowhow over a wide range of professionals inside and outside the complex. In this complex, an "Open Innovation" `a la Chesbrough (2003) can be implemented relatively easily.	3 international firms
Ciccantelli, S. and Magidson, J.	FROM EXPERIENCE: Consumer Idealized Design: Involving Consumers in the Product Development Process	1993	Journal of Product Innovation Management 10	A considerable portion of the growing body of literature devoted to the design process deals with the roles of internal marketing, production, and research and development teams and their interaction. Such design methodologies could be greatly enhanced by focusing more attention on understanding consumer needs and behavior, especially in the initial stages of product development.	Qualitative analysis	Firm-level	Non-applicable		This article discusses how consumer idealized design has helped a number of companies in a variety of industries improve performance by following the above principles. Even companies that tried consumer idealized design, although they felt confident in their existing marketing strategy, have often been surprised at how much they learned, how it affected their beliefs and practices, and how this led to improved performance. In a world where successful performance is increasingly a moving target, companies would be wise to become partners with their consumers in shaping it and pursuing it	Case study
Cohen, Nelson and Walsh	Links and Impacts: The Influence of Public Research on Industrial R&D	2002	Management Science 48	The effect of university research collaboration with corporate R&D.	Quantitative analysis	Industry-level	Within-Industry Determinants of the Influence	Project using public research; Suggesting New R&D projects; Contributing to R&D completion	public research is critical to industrial R&D in a small number of industries and importantly affects industrial R&D across much of the manufacturing sector. Contrary to the notion that university research largely generates new ideas for industrial R&D projects, the survey responses demonstrate that public research both suggests new R&D projects and contributes to the completion of existing projects in roughly equal measure overall.	1267 firms

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Cohen, W. M., and D. A. Levinthal.	Absorptive capacity: A new perspective on learning and innovation.	1990	Administrative Science Quarterly 35	Argue for the firm ability to recognise external value and assimilate it and apply it to commercial ends. This is largely a function of prior related knowledge within the field.	Quantitative Analysis	Firm-level	Fields of knowledge & industry characteristics	R&D spending	R&D spending relates to absorptive capacity	1,719 business units representing 318 firms in 151 Industries
Dahlander, L., and D. M. Gann.	How open is innovation.	2010	Research Policy 39	A clarification of the term openness based on a literature review.	Qualitative analysis	Conceptual	Non-applicable		The paper identifies two inbound processes: sourcing and acquiring, and two outbound processes, revealing and selling. We analyze the advantages and disadvantages of these different forms of openness.	literature review
Dahlander, L., and M. Magnusson.	How do firms make use of open source communities.	2008	Long Range Planning 41	Three themes e accessing, aligning and assimilating e are inductively developed for how the firms relate to the external knowledge created in the communities. Accessing - extending the resource-base of the firm. Aligning - Connecting the firm's strategy with the community. Assimilating - Integrating and sharing results.	Qualitative analysis	Firm-level	Non-applicable		For open innovation it is necessary for the company to embrace a whole new set of subtle control techniques not based on hierarchical positions, but to be able to motivate community members by providing intellectual challenges or some form of monetary reward.	4 open source software firm
Dahlander, L., and M.W. Wallin	A man on the inside: Unlocking communities as complementary assets.	2006	Research Policy 35	Firms try to unlock communities as complementary assets. These communities exist outside firm boundaries beyond ownership or hierarchical control. Because of practices developed by communities to protect their work, firms need to assign individuals to work in these communities in order to gain access to developments and, to an extent, influence the direction of the community.	Quantitative Analysis	Network-level	Firms with open source characteristic, firms with a close characteristic	Ties in the network, prestige within the network, and connection to central members.	differences in how individuals interact, depending on whether their affiliation is with a dedicated FOSS firm or an incumbent in the software industry. Apparently, some firm managers believe they need 'a man on the inside' to be able to gain access to communities.	1659 individuals in open source network
De Faria, P., F. Lima, and R. Santos.	Cooperation in innovation activities: The importance of partners.	2010	Research Policy 39	This paper analyses the importance of cooperation partners for the development of innovation activities.	Quantitative Analysis	Firm-level	Size, export, R&D, Cooperation, Innovation intensity, technology level	Selection Cooperation, Outscome importance.	Results show that firms from high-technological industries, with higher levels of absorptive capacity and of innovation investment, who give importance to incoming spillovers management, and who cooperate with firms from the same group or with suppliers, place greater value on cooperation partners in the innovation process.	766 Portuguese firms.
de Jong, J. P. J., and M. Freel.	Absorptive capacity and the reach of collaboration in high technology small firms	2010	Research Policy 39	This paper is concerned with exploring the role of absorptive capacity in extending the reach of innovation-related collaboration in high technology small firms	Quantitative Analysis	Firm-level	R&D expenditure and intensity, Industry, size, market	Geographical distance	Controlling for a variety of potential influences, higher R&D expenditure is positively related to collaboration with more distant organizations.	316 Dutch firms
Dell'Era, C. and Verganti, R.	Collaborative Strategies in Design-intensive Industries: Knowledge Diversity and Innovation	2010	Long Range Planning 43	Customers are paying increasing attention to product design, whether the aesthetic, symbolic or emotional meanings of products. Designers can support companies in exploring customers' needs and the appropriate signs (such as form, colours, materials, etc) that give meaning to products. Managing collaborations with designers is therefore a critical issue for companies that operate in design-intensive industries.	Quantitative analysis	Firm-level and network-level	Non-applicable, descriptive statistics		This paper shows that companies that innovate collaborate with a broad range of external designers. Most important, innovativeness does not depend on diversity brought by an individual designer, but on diversity brought by the entire portfolio of designers of a firm. The	1,792 products developed by 98 companies through 658 different collaborations. Analysing
Dittrich, K., and G. Duysters.	Networking as a means to strategy change: The case of open innovation in mobile telephony.	2007	Journal of Product Innovation Management 24	This paper analyses how innovation networks can be used to deal with changing technical environments.	Qualitative & Quantitative analysis	Network-level	Partner capabilities, turnover and alliance type.	Network analysis	the importance of strategic technology networks for strategic repositioning under conditions of change. Such inter-firm networks seem to offer flexibility, speed, innovation, and the ability to adjust smoothly to changing market conditions and new strategic opportunities. These two different strategies have led to distinctly different international innovation networks, have helped the company in becoming a world leader in the mobile phone industry, and have enabled it to sustain that position in a radically changed technological environment.	app. 2500 alliances of Nokias
Dodgson, M., D. Gann, and A. Salter.	The role of technology in the shift towards open innovation: The case of Procter & Gamble.	2006	R&D Management 36	This paper analyzes Procter and Gamble's 'Connect and Develop' strategy as a case study of the major organizational and technological changes associated with open innovation. It argues that although some of the organizational changes accompanying open innovation are beginning to be described in the literature, more analysis is warranted into the ways technological changes have facilitated open innovation strategies, particularly related to new product development.	Qualitative analysis	Firm-Level	Non-applicable		The case study shows that a suite of new technologies for data mining, simulation, prototyping and visual representation, what we call 'innovation technology', help to support open innovation in Procter and Gamble.	Proctor & Gamble case study

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Droge, C., M. A. Stanko, and W. A. Pollitte	Lead users and early adopters on the Web: The role of new technology product blogs.	2010	Journal of Product Innovation Management 27	A great deal of information can be learned from blogs, in which early adopters write about technology. NPD managers should therefor pay attention to these sites. This paper focuses on the role of blogs in NPD.	Qualitative analysis	Individual-level	Non-applicable		People voluntarily join new product blogging communities, and if the manager of that product is not "present" (at least as an observer of this "straw poll") an entire new product marketing agenda can be set by the community. Implicitly or explicitly, blogs can position the value proposition of the product in a prime target audience's mind. Such positioning could be advantageous or catastrophic as far as the NPD manager is concerned.	70 blog posts
Du Chatenier, E., J. A. A. M. Verstegen, H. J. A. Biemans, M. Mulder, and O. S.W. F. Omta.	Identification of competencies for profession- als in open innovation teams.	2010	R&D Management 40	This article examines the competencies needed on the individual level for succesful open innovation teamwork.	Qualitative analysis	Individual-level	Non-applicable		professionals can generate new knowledge, build trust, and deal with low reciprocal commitment in open innovation teams. Especially, brokering solutions and being socially competent seem to be important for open innovation professionals.	20 exploratory interviews, and 2 focus groups.
Dushnitsky, G., and J. M. Shaver.	Limitations to interorganizational knowledge acquisition: The paradox of corporate venture capital.	2009	Strategic Management Journal 30	Explores the limitations of interorganizational knowledge acquisition. In the empirical context of corporate venture capital (CVC)	Quantitative Analysis	Firm-level	IPP regime, Industry overlap,	Investment	To the extent that a CVC has greater capability and inclination to target same-industry ventures, such industry overlap would exacerbate imitation concerns under a weak IPP regime, yet facilitate an investment relationship under a strong IPP regime.	1646 US start-ups
Ebner,W., J.M. Leimeister, and H. Krcmar.	Community engineering for innovations: The ideas competition as a method to nurture a virtual community for innovations.	2009	R&D Management 39	Develops a construct called "Community Engineering for Innovation" to allow managers to tap into the collective "brain" thereby trying to manage crowdsourcing efforts.	Qualitative analysis	Individual-level	Trust, Support fear as user characteristics and types of prizes for participating		Draws a variety of practical implications and finds support for the fact the crowdsourcing can be useful as recruitment and theoretical tool.	Data drawn from 60.000 users
Emden, Z., R. J. Calantone, and C. Droge.	Collaborating for new product development: Selecting the partner with maximum potential to create value.	2006	Journal of Product Innovation Management 23	This study investigated the partner selection processes to ascertain the potential of creating competitively advantageous products through collaboration.	Qualitative analysis	Firm-level	Non-applicable		The study's findings suggest that technological alignment of the partners triggered the partner-evaluation process. This phase was followed, in order, by the strategic alignment and relational alignment phases. These later phases were as important as the initial phase in ensuring the transfer and integration of critical know-how and in creating product value through collaboration. In	8 firms divided into 4 cases
Enkel, E., O. Gassmann, and H. Chesbrough	Open R&D and open innovation: Exploring the phenomenon.	2009	R&D Management 39	Presentation for special issue on open innovation in R&D management	Qualitative analysis	Conceptual	Non-applicable		Presentation based on bibliographical research. Demonstrates relevance in a variety of settings.	literature review
Fabrizio, K. R.	Absorptive capacity and the search for innovation.	2009	Research Policy 38	Examines the firms absorptive capacity as it relates to a search for innovation. It is proposed that firms who engage in basic research in collaboration with universities have an advantage when searching for new innovations.	Quantitative Analysis	Firm-level	Firm or university originator. Employee function.	Patents taken	Results indicate that firms with more internally R&D benefit more from collaboration, and firms with more collaboration benefit more from internal R&D. Also, greater external collaboration provides benefits in terms of the pace of search (especially when the firm also possesses greater internal research capabilities) but does not independently affect the quality of search outcome.	83 Biotech firms
Faems, D., M. de Visser, P. Andries, and B. van Looy.	Technology alliance portfolios and financial performance: Value-enhancing and cost-increasing effects of open innovation.	2010	Journal of Product Innovation Management 27	Test the value enhancing and cost increasing effect of using technology alliances on financial performance.	Quantitative Analysis	Firm-level	Technology alliance portfolio, Internal innovation effect, Product innovation performance.	Financial performance (personnel cost and profit margins)	A direct cost-increasing effect of technology alliance portfolio diversity on financial performance is observed.Moreover, the structural equation analyses suggest that, in the short-term, the direct cost-increasing effect of technology alliance portfolio diversity exceeds the indirect value-generating effect of technology alliances.	526 Belgian manufacturing firms
Faems, Van Looy and Debackere,	Interorganizational collaboration and innovation: Toward a portfolio approach	2005	Journal of Product Innovation Management 22	Impact of inter-organizational collaboration NPD performance of firms.	Qualitative analysis	Firm-level	Indicators for effectiveness of innovation strategy; Indicators for collaboration.	Turnover	More collaborators leads to new and improved products. Diverse collaborators leads to diverse innovation outcomes.	221 firms from the Belgian community innovation survey (CIS-2).
Fichter, K.	Innovation communities: The role of networks of promoters in open innovation.	2009	R&D Management 39	Creates a new definition for innovation communities in which a transformational leaders and networking of champions is key in defining networks as networks of promoters. Within promoter theory success of innovation is based on promoters overpowering barriers to innovation.	Qualitative analysis	Firm-Level	Non-applicable		Transformational leaders or promoters and especially their close and informal co-operation across functional and organisational boundaries and across different levels of innovation systems, can play a key role in Open Innovation.	3 case studies
Foss, N. J., K. Laursen, and T. Pedersen.	Linking customer interaction and innovation: The mediating role of new organizational practices.	2011	Organization Science 22	When engaging in external collaboration with users or communities the firm needs the right organization to utilise these resources. This can be achieved in particular through the use of new organizational practices, notably, intensive vertical and lateral communication, rewarding employees for sharing and acquiring knowledge, and high levels of delegation of decision rights.	Quantitative Analysis	Firm-level	Customer involvement and communication, Employee characteristics, Strategy characteristics.		A key result is that the link from customer knowledge to innovation is completely mediated by organizational practices.	169 Danish firms

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Frenz, M., and G. Ietto-Gillies.	The impact on innovation performance of different sources of knowledge: Evidence from the UK Com- munity Innovation Survey.	2009	Research Policy 38	Examines the difference between in-house R&D and external R&D on innovation performance and how these two interact. Especially, in situations where international collaboration is involved.	Quantitative Analysis	Firm-level	Internal or external R&D, Cooperation characteristics.	Innovation sales	The paper explores the benefit of in-house development and external sourcing of innovation on NPD performance. While the benefits of both are demonstrated the value of cooperation is still unclear. The interactions between the own-generation of knowledge and external sources increase the innovation potential of enterprises.	171 firms
Füller, J., K. Matzler, and M. Hoppe.	Brand community members as a source of innovation.	2008	Journal of Product Innovation Management 25	Brand community members have a strong interest in the product and in the brand. They usually have extensive product knowledge and engage in product-related discussions; they support each other in solving problems and generating new product ideas. Therefore, brand communities can be a valuable source of innovation. So far, little is known about the member's ability and willingness to participate in a company's innovation process. How	Quantitative Analysis	Individual-level	Structural equation modelling		This paper introduces a comprehensive set of antecedents affecting brand community members' willingness to engage in new product development. It is argued that consumer creativity, identification with the brand community, and brand-specific emotions and attitudes (passion and trust) as well as brand knowledge are important determinants of consumers' willingness to share their knowledge with producers. The paper also identifies two personality traits (i.e., extraversion and openness) that have significant influence on brand passion, creativity, and identification with the community.	550 members of a Volkswagen community
Gassmann, O.	Opening up the innovation process: towards an agenda	2006	R&D Management 36	Although a trend towards open innovation can be observed, open innovation is not an imperative for every company and every innovator. Instead, there is a need for a contingency approach regarding the management of innovation: Which of the factors that drive higher performance are preferred by open and which by closed innovation models need to be determined. The nuclear and military industries are typical examples of closed innovation industries in which non-proliferation of technology and protection remain important. The more an industry's idiosyncrasies correspond to the following developments and trends, the more appropriate the open innovation model seems to be.	Qualitative analysis	Conceptual	Non-applicable		Drivers of open innovation: 1. Globalization, 2. Technology Intensity, 3. Technology Fusion, 4. New Business Models, 5. Knowledge Leveraging, Also covers different literature steams that impacts the open innovation field.	Conceptual
Gassmann, O., P. Sandmeier, and C. H. Wecht.	Extreme customer innovation in the front-end: Learning from a new software paradigm.	2006	International Journal of Technology Management 33	The front-end phase of the innovation process constitutes up to two-thirds of the total cost of new product development (NPD). In response to the new open innovation paradigm, new ways to integrate customers' knowledge into the innovation front-end must be explored. In an attempt to learn from analogous situations in which the interface between developers and customers has been managed successfully, this article analyses the Extreme Programming (XP) approach of software engineering.	Qualitative analysis	Firm-level	Non-applicable		Four determinants are identified for front-end management that reside between creativity and resource efficiency. These determinants dictate the potential for front-end effectiveness improvement and enable the maximum amount of knowledge generation and absorption from the customer: customer needs, Product system architecture, Project planning and NPD organization.	20 technology firms
Gillier, T.,G. Piat, B. Roussel, and P. Truchot.	Managing innovation fields in a cross-industry exploratory partnership with C-K design theory.	2010	Journal of Product Innovation Management 27	For a few decades now, firms have had to innovate in cooperation with other organizations. According to the literature on co-innovation, a new form of innovation partnership is now emerging: the exploratory partnership. This type of partnership is the most often established in the early stages of the design process and faces high levels of uncertainty and instability.	Qualitative analysis	Network-level	Non-applicable		Articles shows that the use of an online framework for project processing Such representations enable the committee to identify the main value of a project, any knowledge gaps and the synergies between projects.	Single case study
Gnyawali, D. and Park, B.	Co-opetition between giants: Collaboration with competitors for technological innovation	2011	Research Policy 40	Why and how does co-opetition (simultaneous pursuit of collaboration and competition) between large firms occurs, evolves, and impacts the participating firms and the industry.	Qualitative analysis	Firm-level	Non-applicable		The study demonstrates that co-opetition is challenging yet very helpful for firms to address major technological challenges, to create benefits for partnering firms, and to advance technological innovation. Moreover, co-opetition between giants causes subsequent co-opetition among other firms and results in advanced technological development.	Case study with Sony and JV
Grimpe, C., and W. Sofka.	Search patterns and absorptive capacity: Low- and high-technology sectors in European countries.	2009	Research Policy 39	Searching for externally available knowledge has been characterised as a vital part of the innovation process. Previous research has, however, almost exclusively focused on high-technology environments, largely ignoring the substantial low- and medium-technology sectors of modern economies. We	Quantitative Analysis	Firm-level	R&D characteristics, Employees w. graduate Education	Share of turnover with market novelty	Search patterns in low-technology industries focus on market knowledge and that they differ from technology sourcing activities in high-technology industries.	4500 firms from 13 European Countries
Hagedoorn, J.	Understanding the rationale of strategic technology partnering: interorganizational modes of cooperation and sectoral differences	1993	Strategic Management Journal 14	Interfirm strategic alliances is an important part of international business.	Quantitative analysis	Network-level	Non-applicable, descriptive statistics		Firms engage in strategic partnersship for two primary reasons. Market or technology access.	over 4000 alliances across industries

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Hagedoorn, J.	Inter-firm R&D partnerships: an overview of major trends and patterns since 1960	2002	Research Policy 31	provides an overview of some major international (sectoral) patterns in the forming of R&D partnership	Quantitative Analysis	Firm-level	Longiditutional data on R&D partnering		A major conclusion from the above is that R&D partnering is a 'game' dominated by companies from the world's most developed economies. As companies from the developed economies participate in 99% of the R&D partnerships and 93% of these partnerships are made amongst companies from North America, Europe, Japan and South Korea, little appears left for companies from other regions	around 700 R&D partnerships
Handfield, R. Ragatz, G. Petersen, K. and Monczka, R.	Involving Suppliers in New Product Development	1999	California Management Review 42	In a competitive environment, suppliers are an increasingly important resource for manufacturers. Across all worldwide manufacturers, purchased materials account for over 50 percent of the cost of goods sold. In addition, suppliers have a large and direct Impact on the cost, quality, technology, and time-to-market of new products. Effective integration of suppliers into the product value/supply chain will be a key factor for manufacturers in achieving the improvements necessary to remain competitive. As integration increases, joint resource dedication will follow.	Quantitative analysis	Firm-level	Non-applicable		Results of the survey show that the responding companies achieved significant improvements in project results when suppliers participated, compared to similar new product development projects in which suppliers were not involved. These results reveal the potential benefits from involving suppliers in new product development efforts and demonstrate an important competitive advantage for companies that can manage this integration successfully.	134 firms
Henkel, J.	Selective revealing in open innovation processes: The case of embedded Linux.	2006	Research Policy 35	Explores informal innovation collaboration in the the open source software business.	Quantitative Analysis	Individual and firm-level	Openness policy, Firm type, Reasons for collaborating.	Share of code revealed	Shows different reasons for collaboration whether it be marketing, development, or reputation.	268 linux developers
Hillebrand, B., and W. G. Biemans.	Links between internal and external cooperation in product development: An exploratory study.	2004	Journal of Product Innovation Management 21	This article studies how internal and external cooperation relate in organization.	Qualitative & Quantitative analysis	Firm-level	flexibility, information exchange, solidarity		Both internal and external cooperative norms were examined, allowing for the conclusion that internal and external cooperative norms were very similar. While only a limited effect of cooperative norms on cooperative behavior was found. This study concludes that internal and external cooperative norms are related and that they may provide an underlying mechanism for the suggested relationship between internal and external cooperation, but the results regarding the link between cooperative norms and behaviour as yet are inconclusive.	6 product development projects
Holmes, S., and P. Smart.	Exploring open innovation practice in firm-nonprofit engagements: A corporate social responsibility perspective.	2009	R&D Management 39	This paper examines the concept of open innovation within the context of corporate social responsibility. It demonstrates how the practice of open innovation unfolds in inter-organizational collaborations that involve the voluntary or charitable sector, outlining the findings of an explorative collective case study of eight voluntary dyadic partnerships between corporate and nonprofit organizations in the United Kingdom, which have resulted in innovation outcomes.	Qualitative analysis	Firm-level	Non-applicable		This research demonstrates the value of an open innovation approach driven by the need to address societal and social issues (rather than those purely economic). Such practice broadens a firm's 'search' activities and delivers innovations in exchange for enhanced social legitimacy – acting innovation capital for future enterprising activities and market advantage.	8 dyadic relationships between for-profit and Non-profit entities
Hughes, B., and J. Wareham.	Knowledge arbitrage in global pharma: A synthetic view of absorptive capacity and open innovation.	2010	R&D Management 40	This article looks at how open innovation strategies are used in the NPD portfolio of a large pharmaceutical industry.	Qualitative analysis	Firm-level	Non-applicable		This article found a focus on open innovation capability building, external information sharing and uncertain knowledge arbitrage in networks	Single case study with 120 managers in pharmaceutical firm
I. Serhan, A. Albers, and S. Miller.	Open innovation in the automotive industry.	2010	R&D Management 40	Open innovation in the automotive industry. Because of an increasing innovation and cost pressure, the automotive industry needs to look outside their own boundaries to escape from this productivity dilemma. While there is a tendency to look outside for external sources to increase the innovativeness, there are hardly any external paths to market outside the current business	Qualitative analysis	Firm-level	Non-applicable		A sustainable support from top-management is one of the most important key factors for implementing Open Innovation. Only a top-down strategy to open up the innovation process increases awareness of potential benefits to all other employees involved. Open innovation should be a result of an explicit top-down strategy.	42 firms in the automotive industry.

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Jacobides, M. G., and S. Billinger.	Designing the boundaries of the firm: From “make, buy, or ally” to the dynamic benefits of vertical architecture.	2006	Organization Science 17	The concept of "vertical architecture" defines the scope of a firm and the extent to which it is open to final and intermediate markets; il describes the configurations of transactional choices along a firm's value chain. A firm can make or buy inputs, and transfer outputs downstream or sell them. Permeable vertical architectures are partly integrated and partly open to the markets along a firm's value chain. Increased permeability enables more effective use of resources and capacities, better matching of capabilities with market needs, and benchmarking to improve efficiency. Partial	Qualitative analysis	Firm-level	Non-applicable		This study suggests that to understand how firm boundaries are set and what their impacts are. we need to complement the microanalytic focus on transactions with a systemic analysis at the level of the firm. It also shows how, over and above transactional alignment, decisions about boundaries and vertical architectures can transform a firm's strategic and productive capabilities and prospects.	1 case study
Jeppesen, L. B., and K. R. Lakhani.	Marginality and problem-solving effectiveness in broadcast search.	2010	Organization Science 21	The article examines the winners are in science problem solving contests characterized by open broadcast of problem information, self-selection of external solvers to discrete problems from the laboratories of large R&D intensive companies and blind review of solution submissions.	Quantitative Analysis	Firm-level	Expertise distant, Gender, Ethnicity, Previous problems, Solver interests.	Which solver submits a winning solution	The findings contribute to the emerging literature on open and distributed innovation by demonstrating the value of openness, at least narrowly defined by disclosing problems, in removing barriers to entry to non-obvious individuals	166 science contest in Incentive involving over 12.000 scientist
Jeppesen, L. B., and L. Frederiksen.	Why do users contribute to firm-hosted user communities? The case of computer-controlled music instruments.	2006	Organization Science 17	This study looks at the key personal attributes of the individuals responsible for innovations, namely the innovative users, to explain creation of value in this organizational context. The main question is why such users contribute to firm-hosted user communities. Analyzing	Quantitative Analysis	Network-level	Professional, Lead user, Motivation	Innovation in users	This study finds that innovative users are likely to be (i) hobbyists, an attribute that can be assumed to (positively) affect innovators' willingness to share innovations, and (ii) responsive to "firm recognition" as a motivating factor for undertaking innovation, which explains their decision to join the firm's domain.	345 users
Keupp, M. M., and O. Gassmann.	Determinants and archetype users of open innovation.	2009	R&D Management 39	Past theoretical contributions have focused on explaining the externalisation of R&D activities as a result of firm-external factors, this article focus on explaining this externalisation as a result of firm-internal weaknesses, specifically, impediments to innovation. Using the exploration–exploitation dichotomy as this theoretical framework, is used to develop hypotheses on how impediments to innovation influence the breadth and depth of OI.	Quantitative Analysis	Firm-level	Firm related impediments to innovation.	Breath and depth of open innovation.	This article identifies four ‘archetypes’ of firms that differ significantly regarding the breadth and depth of open innovation and the importance of impediments. 1. professionals. 2. Explorers, 3. Scouts and 4. Isolationist.	app 2300 firm in switzerland
Kirschbaum, R.	Open innovation in practice. Research-Technology	2005	Research-Technology Management 48	By combining internal and external competencies and knowledge, both in R&D and marketing. the multinational life sciences and performance materials company DSM is opening up its innovation process. DSM recognizes that successful, profitable innovation depends upon teamwork and an entrepreneurial culture. The	Qualitative analysis	Firm-level	Non-applicable		Successful, profitable innovation depends upon teamwork and an intrapreneurially culture. It is not enough simply to identify technologies that are ripe for innovation—to create real value, it is necessary first to identify what is needed in particular market segments and then to identify which technologies can be adapted or developed to meet this need. Value creation requires a coherent strategy.	1 case study
Kohler, T.,K. Matzler, and J. Füller.	Avatar-based innovation: Using virtual worlds for real-world innovation.	2009	Technovation 29	The purpose of this article is to explore the opportunities virtual worlds offer for real-world innovations. By integrating users of virtual worlds into an interactive new product development process, companies can tap customers’ innovative potential using the latest technology. Connecting the emerging technology of virtual worlds with a customer-centric perspective of open innovation allows unique and inventive opportunities to capitalize on users’ innovative potential and knowledge. The concept of avatar-based innovation serves as a point of origin to reveal these possibilities and represents the first attempt to systematically take advantage of virtual worlds for innovation management. In doing so, this paper argues that latest advances of information and communication technologies enrich the interaction process and can improve new product development process. Further,	Qualitative analysis	Firm-level and Individual-level	Non-applicable		A few pathfinding companies experiment with avatars as a source of innovation. Specifically, the initiatives of Osram, Steelcase, Mazda, and Toyota truly link the concepts of open innovation and virtual worlds to employ the interactive technology for new product development. These efforts are critically analyzed to examine the hypothesized potential of avatar-based innovation. The cases pinpoint practical implications and reveal both preconditions and challenges of this new approach to interactive new product development. The results suggest that in order to fully realize the potential of avatar-based innovation, companies need to create a compelling open innovation experience and consider the peculiarities of virtual worlds	8 mangers and 16 customers

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Lakhani, K. R., and E. von Hippel.	How open source software works: "Free" user-to-user assistance.	2003	Research Policy 32	Research into free and open source software development projects has so far largely focused on how the major tasks of software development are organized and motivated. But a complete project requires the execution of "mundane but necessary" tasks as well. The paper explores how the mundane but necessary task of field support is organized in the case of Apache web server software, and why some project participants are motivated to provide this service gratis to others.	Quantitative Analysis	Individual-level	Information attributes	Information providers	When Partitioning the help system into its component tasks, 98% of the effort expended by information providers in fact returns direct learning benefits to those providers. This finding considerably reduces the puzzle of why information providers are willing to perform this task "for free."	Apache Software platform
Lambe, C. J., and R. E. Spekman.	Alliances, external technology acquisition, and discontinuous technological change.	1997	Journal of Product Innovation Management 14	This research examines the effect of an alliance competence on resource-based alliance success. The fundamental thesis guiding this research is that an alliance competence contributes to alliance success, both directly and through the acquisition and creation of resources.	Quantitative Analysis	Network-level	Complementary resources, idiosyncratic resources, Senior management commitment.		Results support the view that complementary and idiosyncratic resources affect alliance success, but they also indicate that (1) complementary resources have only an indirect effect on alliance success through idiosyncratic resources, and (2) an alliance competence also has an indirect effect on alliance success through idiosyncratic resources. These findings suggest that idiosyncratic resources are a key mediating variable that influences alliance outcomes. In	145 alliances
Lau, A. K.W., E. Tang, and R. C. M. Yam.	Effects of supplier and customer integration on product innovation and performance: Empirical evidence in Hong Kong manufacturers.	2010	Journal of Product Innovation Management 27	While the beneficial impacts of supplier and customer integration are generally acknowledged, very few empirical research studies have examined how an organization can achieve better product performance through product innovation enhanced by such integration. This paper thus examines the impact of key supplier and customer integration processes (i.e., information sharing and product codevelopment with supplier and customer, respectively) on product innovation as well as their impact on product performance.	Quantitative Analysis	Firm-level	Information sharing, Co-development	Product performacne	The empirical findings show that product co-development with suppliers improves performance, mediated by innovation. However, the sampled firms cannot improve their product innovation by sharing information with their current customers and suppliers as well as codeveloping new products with the customers. If the adoption of supplier and customer integration is not cost free, the findings of this study may suggest firms work on particular supplier and customer integration processes (i.e., product codevelopment with suppliers) to improve their product innovation. The study also suggests that companies codevelop new products only with new customers and lead users instead of current ones for product innovation.	251 manufacturers in Hong Kong
Laursen, K., and A. Salter.	Searching high and low: what types of firms use universities as a source of innovation? Keld	2004	Research Policy 33	This paper examines the factors that influence why firms draw from universities in their innovative activities. The link between the universities and industrial innovation, and the role of different search strategies in influencing the propensity of firms to use universities is explored.	Quantitative analysis	Firm-level	R&D intensity, Long-term R&D, Start-up	Use of knowledge created in universities for technological innovation	The results suggest that firms who adopt "open" search strategies and invest in R&D are more likely than other firms to draw from universities, indicating that managerial choice matters in shaping the propensity of firms to draw from universities.	2655 firms from UK CIS
Laursen, K., and A. Salter.	Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms	2006	Strategic Management Journal 27	A central part of the innovation process concerns the way firms go about organizing search for new ideas that have commercial potential. New models of innovation have suggested that many innovative firms have changed the way they search for new ideas, adopting open search strategies that involve the use of a wide range of external actors and sources to help them achieve and sustain innovation.	Quantitative Analysis	Firm-level	Breath and Depth of collaboration	Innovation performance	introduced two new concepts—external search breadth and external search depth—to describe the character of a firm's strategies for accessing knowledge from sources outside of the firm. This study suggests that the enthusiasm for openness needs to be tempered by an understanding of the costs of such search efforts. It suggests external sources need to be managed carefully so that search efforts are not dissipated across too many search channels.	2707 UK Manufacturing firms
Laursen, K., M. I. Leone, and S. Torrisi.	Industrial and Corporate Change 19	2010	Industrial and Corporate Change 19	The issue of the factors that affect how technologically distant from the existing technological portfolio in-licensing firms are able to move when they in-license externally developed technologies.	Quantitative Analysis	Firm level	Assimilation, monitoring, Patents	Technology exploration	showed that assimilation capacity is an important determinant of the ability to explore distantly from the firms' existing technological portfolio. The negative sign of monitoring ability scale was, however, unexpected. Although our cross sectional design does not allow for a dynamic explanation of this result, we can speculate that firms alternate phases of exploration, whereby they monitor the external technological space, with phases of exploitation during which they assimilate and further develop what they have learned from past exploration. This reasoning is in line with the proposition that exploration and exploitation are complements in the long run but are likely to be substitutes at a given point in time (they are synchronically substitutes).	176 license agreements
Lee, S., G. Park, B.Yoon, and J. Park.	Open innovation in SMEs: An intermediated network model.	2010	Research Policy 39	This article, which seeks, firstly, to place the concept of open innovation in the context of SMEs; secondly to suggest the input of an intermediary in facilitating innovation; and finally to report accounts of Korean SMEs' success in working with an intermediary.	Quantitative Analysis	Firm-level	Non-applicable		The research results support the potential of open innovation for SMEs, and indicate networking as one effective way to facilitate open innovation among SMEs.	2743 Korean firms

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Li, Y., and W. Vanhaverbeke.	The effects of inter-industry and country difference in supplier relationships on pioneering innovations.	2009	Technovation 29	This paper analyzes how the knowledge differences between the innovating firms and their suppliers in Canada are likely to result in pioneering innovations. The knowledge difference is decomposed into two dimensions: the inter-industrial dimension and the geographic dimension in national context.	Quantitative Analysis	Firm-level	Country difference, Industry difference, firm size.		This paper found the inter-industry difference has a positive effect and the country difference has a negative effect on the likelihood of generating pioneering innovation. The findings of this paper suggest that for generating pioneering innovation, it is important not only to search for suppliers from different industries to get access to various complementary external knowledge sources but also to find suppliers from the same or nearby countries for the sake of communication and coordination.	595 innovations
Link, A. N., and J. Rees.	Firm size, university based research, and the returns to R&D.	1990	Small Business Economics 2	This paper compares university-based research relationships between small and large firms as an explanation for the difference in innovative activity across firm sizes.	Quantitative Analysis	Firm-level	Non-applicable		While the results presented in this paper by no means explain fully why small firms have an innovation-related advantage over large firms, they do point out one interesting difference between an aspect of large and small firm research behavior. Although large firms are more active in university-based research per se, small firms appear to be able to utilize their university-based associations to leverage their internal R&D to a greater degree than large firms.	209 firms
Miotti and Sachwald	Why and with whom? An integrated framework of analysis.	2003	Research Policy 32	What determines choice of external partners in NPD.	Quantitative analysis	Firm-level	Sectoral variables; firm characteristics; Obstacles to innovation; Public funding.	Co-operation.	Trans-Atlantic co-operation more effective than intra-european co-operation for French Firms.	2378 firms from the French version of European Community Innovation Survey (CIS-2).
Morrison, P. D., J. H. Roberts, and E. von Hippel.	Determinants of user innovation and innovation sharing in a local market. Management	2000	Management Science 46	This article explores the characteristics of innovation, innovators, and innovation sharing by library users ofOPACinformation search systems in Australia. This market has capable users, but it is nonetheless clearly a "follower" with respect to worldwide technological advance.	Quantitative Analysis	Firm-level	Users, manufacturer evolution of user innovation, User perceptions	Innovation Sharing	This article finds that 26% of users in this local market nonetheless do modify their OPACs in both major and minor ways, and that OPAC manufacturers judge many of these user modifications to be of commercial interest. The article finds that one can distinguish modifying from non-modifying users on the basis of a number of factors, including their "leading-edge status" and their in-house technical capabilities. Many innovating users freely share their innovations with others, and find that we can distinguish users that share information about their modifications from users that do not.	122
Mortara, L., R. Thomson, C. Moore, K. Armara, C. Kerr, R. Phaal, and D. Probert.	Developing a technology intelligence strategy at Kodak European Research: Scan & target.	2010	Research-Technology Management 53	Kodak European Research (KER) developed a strategy for technology intelligence based on a theoretical model developed by Kerr et al. (2006). KER scouts designed and implemented a four-step approach to identify relevant technologies and research centers across Europe, Africa and the Middle East. The approach provides clear guidance for integrating web searches, scouting trips, networking and interactions with intermediaries. KER s example illustrates how companies can organize themselves to look outside corporate boundaries in search of technologies relevant for their business. T	Qualitative analysis	Firm-level	Non-applicable		Three years since the opening of KER, the development and application of their TI strategy has greatly enhanced the ability of the center to achieve its aims. The TI strategy has allowed Kodak to follow its open innovation model and make the most of the opportunities available in the greater European region.	Single case study
Murray, F, and O'Mahony, S.	Exploring the Foundations of Cumulative Innovation: Implications for Organization Science.	2007	Organization Science 18	For innovation to occur, knowledge must not just be shared, but also reused, recombined, and accumulated	Qualitative analysis	Firm-level and network-level	Non-applicable		innovators encounter barriers to the accumulation of knowledge, their solutions are often organizational ones rather than legal ones.	Conceptual
Nicholls-Nixon, C. L., and C. Y. Woo.	Technology sourcing and output of established firms in a regime of encompassing technological change.	2003	Strategic Management Journal 24	This paper argues that when the technological basis of an industry is changing, the firm's approach to technology sourcing plays a critical role in building the capabilities needed to generate new technical outputs.	Quantitative Analysis	Firm-level	Investment in R&D, Technological Breath, Type of alliances, Number of alliances	Biotech patents, Biotech products, Reputation	This paper finds that different approaches to technology sourcing (internal R&D and external R&D) are related to different types of biotechnology-based output at the end of the period. Internal R&D was positively associated with patent output. Acquisition activity was positively related to number of biotechnology-based products. Greater use of R&D contracts and licenses was associated with stronger reputation for possessing expertise in biotechnology.	26 biotech firms

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Nieto, M. J., and L. Santamaría.	The importance of diverse collaborative networks for the novelty of product innovation.	2007	Technovation 27	This paper theoretically and empirically analyzes the role of different types of collaborative networks in achieving product innovations and their degree of novelty.	Quantitative Analysis	Firm-level	Collaboration and continuity, Types of parternes and networks.	High and low degree of novelty of product innovations	The results show that technological collaborative networks are of crucial importance in achieving a higher degree of novelty in product innovation. Continuity of collaboration and the composition of the collaborative network are highly significant dimensions. Collaboration with suppliers, clients and research organizations—in this order—have a positive impact on the novelty of innovation, while collaboration with competitors has a negative impact. The greatest positive impact on the degree of innovation novelty comes from collaborative networks comprising different types of partners.	1300 firms
Petersen, K. Handfield, R. and Ragatz G.	Supplier integration into new product development: coordinating product, process and supply chain design	2005	Journal of Operations Management 23	In many industries, firms are seeking to cut concept to customer development time, improve quality, reduce the cost of new products and facilitate the smooth launch of new products. Prior research has indicated that the integration of material suppliers into the new product development (NPD) cycle can provide substantial benefits towards achieving these goals. This involvement may range fromsimple consultation with suppliers on design ideas to making suppliers fully responsible for the design of components or systems they will supply. Moreover, suppliers may be involved at different stages of the new product development process.	Quantitative analysis	Firm-level	Detailed supplier assessment, technical assessment, Business assessment, Project team effectiveness	Firm financial performance, Design performance.	The findings emphasizes the criticality of the supplier selection decision in this type of effort, considering not only the capabilities of the supplier, but also the culture of the supplier, which will have an impact on the buying firm's ability to interact with the supplier effectively. Careful attention to this decision is important regardless of the stage of the new product development cycle at which the supplier will be integrated, and regardless of the level of responsibility the supplier will be assigned in the project. The findings also highlight two important types of input that buying firms might seek from the supplier. Involving the supplier in the determination of appropriate technical metrics and targets for the project, and agreeing jointly with the supplier on these targets was shown to be a key element in project team effectiveness.	134 respondents from 18 countries
Petersen, K. Handfield, R. and Ragatz G.	A Model of Supplier Integration into New Product Development	2003	Journal of Product Innovation Management 20	In many industries, firms are looking for ways to cut concept-to-customer development time, to improve quality, and to reduce the cost of new products. One approach shown to be successful in Japanese organizations involves the integration of material suppliers early in the new product development cycle. This involvement may range from simple consultation with suppliers on design ideas to making suppliers fully responsible for the design of components or systems they will supply.	Quantitative analysis	Firm-level	Customer knowledge of suppliers. Technology and Cost information sharing, Supplier involvement in decision making, Technology uncertainty, Project outcomes.		The results suggest that (1) increased knowledge of a supplier is more likely to result in greater information sharing and involvement of the supplier in the product development process; (2) sharing of technology information results in higher levels of supplier involvement and improved outcomes; (3) supplier involvement on teams generally results in a higher achievement of NPD team goals; (4) in cases when technology uncertainty is present, suppliers and buyers are more likely to share information on NPD teams; and (5) the problems associated with technology uncertainty can be mitigated by greater use of technology sharing and direct supplier participation on new product development teams. A supplier's participation as a true member of a new product development team seems to result in the highest level of benefits, especially in cases when a technology is in its formative stages.	17 Japanese and American Manufacturing firms
Piller, F. T., and D. Walcher.	Toolkits for idea competitions: A novel method to integrate users in new product development.	2006	R&D Management 36	Research has shown that many innovations originate not in the manufacturer but the user domain. Internet-based toolkits for idea competitions (TIC) are a novel way for manufacturers to access innovative ideas and solutions from users. Idea competitions build on the nature of competition as a means to encourage users to participate at an open innovation process, to inspire their creativity, and to increase the quality of the submissions. When the contest ends, submissions are evaluated by an expert panel. Users whose submissions score highest receive an award from the manufacturer, which is often granted in exchange for the right to exploit the solution in its domain.	Qualitative analysis	Network-level	Non-applicable		Adidas' management was very satisfied with the quality of the submissions in general, and rather enthusiastic about the winning ideas. Two of them are presently in the state of implementation. But to open the internal NPD process continuously for user input, Adidas – as most other organizations – has to establish more formal organizational structures supporting this practice.	Single case study
Poetz, M. K., and M. Schreier.	The value of crowdsourcing: Can users really compete with professionals in generating new product ideas.	2012	Journal of Product Innovation Management 29	Both professionals and users provided ideas to solve an effective and relevant problem in the consumer goods market for baby products. Executives from the underlying company evaluated all ideas (blind to their source) in terms of key quality dimensions including novelty, customer benefit, and feasibility	Quantitative Analysis	Individual-level	Novelty, Customer benefit, Feasibility,	Idea Quality	The study reveals that the crowdsourcing process generated user ideas that score significantly higher in terms of novelty and customer benefit, and somewhat lower in terms of feasibility. However, the average values for feasibility—in sharp contrast to novelty and customer benefit—tended to be relatively high overall, meaning that feasibility did not constitute a narrow bottleneck in this study. Even more interestingly, it is found that user ideas are placed more frequently than expected among the very best in terms of novelty and customer benefit	51 ideas generated for 1 firm

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Prahalad, C. K., and V. Ramaswamy.	Co-creation experiences: The next practice in value creation.	2004	Journal of Interactive Marketing 18	The meaning of value and the process of value creation are rapidly shifting from a product- and firm-centric view to personalized consumer experiences. Informed, networked, empowered, and active consumers are increasingly co-creating value with the firm.The interaction between the firm and the consumer is becoming the locus of value creation and value extraction. As value shifts to experiences, the market is becoming a forum for conversation and interactions between consumers, consumer communities, and firms. It is this dialogue, access, transparency, and understanding of risk- benefits that is central to the next practice in value creation.	Qualitative analysis	Conceptual	Non-applicable		Firms have traditionally opposed transparency. The fight against product labeling is well known. Releasing information regarding the likely risks is often mandated. It must become voluntary. Further, transparency and access are of little value if the firms do not create the infrastructure for dialog. This requires investment in technology but more important, investments in socializing managers and changing managerial practices. What is emerging is that dialog requires us to invest time and effort to understand the economics of experience and develop systems to come to agreements rapidly. Finally, firms must recognize that the more educated the consumer, the more likely it is that she will make an intelligent choice and make tradeoffs that are appropriate.	Conceptual
Raasch, C., C. Herstatt, and K. Balka.	On the open design of tangible goods.	2009	R&D Management 39	Open source software development has received considerable scholarly attention, much of which is based on the presumption that the 'open source model' holds some lessons of broader applicability. Nonetheless, our knowledge of its deployment outside the software industry is very limited. This paper focuses on the open source development of tangible objects, the so- called open design.	Qualitative analysis	Firm-level	Non-applicable		The analysis reveals that open design is already being implemented in a substantial variety of projects with different organisational and institutional structures.	6 comparative case studies
Ransbotham, S., and S. Mitra.	Target age and the acquisition of innovation in high-technology industries.	2010	Management Science 56	External acquisition of new technology is a growing trend in the innovation and product development process, particularly in high-technology industries, as firms complement internal research and development efforts with aggressive acquisition programs. Yet, despite its importance, there has been little empirical research on the timing of acquisition decisions in high-technology environments.	Qualitative analysis	Firm-level	Non-applicable		The analytical model and empirical analysis uncover two characteristics of young targets that drive benefits from early acquisitions—flexible growth options that provide greater opportunities for synergistic fit, and greater valuation uncertainty that leads to lower prices. However, the negative effect of target age on acquirer value is partially mitigated if the target has recent patents or is privately held. In addition, the probability of acquisition is higher for targets that have signals of higher quality, and lower for targets that have superior access to capital and resources.	140 mergers and acquisitions.
Ritala, P. and Hurmelinna-Laukkanen, P.	Incremental and Radical Innovation in Coopetition—The Role of Absorptive Capacity and Appropriability	2013	Journal of Product Innovation Management 30	This study examines why some firms are better able than others to reap benefits from collaborating with their competitors in innovation. Whereas on the general level, collaborative innovation has been studied widely, and firm-specific success factors in collaboration between competitors (i.e., coopetition) have not been exhaustively addressed.	Quantitative analysis	Firm-level	R&D collaboration, R&D intensity, Technology development,	Radical and incremental innovation	the results presented in this study provide new evidence on which types of firms can reap success in the challenging task of collaborative innovation with rivals. In the case of incremental innovation, a firm-level emphasis on knowledge sharing and learning will positively affect the results of coopetition, as will an emphasis on knowledge protection. Thus, when incremental developments are pursued in coopetition, firms should not only seek to exchange knowledge to create value but also remember to secure the firm-specific core knowledge within the firm's borders to stay competitive. On the other hand, when the firm is pursuing radical innovation with its rivals, the heaviest emphasis should be on protecting its existing core knowledge and also emerging novel innovations and market opportunities. Capabilities in knowledge acquisition are also beneficial in these cases, but the full benefits of knowledge exchange realize only when the firm's knowledge protection mechanisms are sufficiently strong, allowing for safe knowledge exchange between rivals.	213 Finnish firms
Rohrbeck, R.	Harnessing a network of experts for competitive advantage: Technology scouting in the ICT industry.	2010	R&D Management 40	In order to identify discontinuous technological change and develop appropriate action, companies are increasingly building technology foresight (TF) practices. This paper explores how, using networks of experts, TF capabilities can be built. On	Qualitative analysis	Firm-level	Non-applicable		Using insights from the three major telecommunication incumbents in Europe, the paper describes and discusses (1) what can be achieved by technology scouting, (2) how a process can be set up, (3) what is important in the design of a scouting network, and (4) the characteristics that should be aimed for when choosing technology scouts. The	3 case studies
Rohrbeck, R., K. Hölzle, and H. G. Gemünden.	Opening up for competitive advantage: How Deutsche Telekom creates an open innovation ecosystem	2009	R&D Management 39	The aim of this study is to analyse to what extent the open innovation paradigm has been embraced inside this now multinational telecommunication company.	Qualitative analysis	Firm-level	Non-applicable		Using empirical evidence from 15 in-depth interviews, we identify 11 open innovation instruments and detail their value contribution. We can show that Deutsche Telekom has successfully enhanced its innovation capacity by opening up its traditional development process and embracing external creativity and knowledge resources.	Single case study
Rothaermel, F. T., and A. M. Hess.	Building dynamic capabilities: Innovation driven by individual-, firm-, and network-level effects. Organization	2007	Organization Science 18	Assess the direct effects of antecedents at the individual, firm, and network levels on innovation output.	Quantitative Analysis	Individual, Firm-level & Network-level	Years, patents, & expenditures.	Biotech papenting	Antecedents to innovation lie across different levels of analysis and can have compensating or reinforcing effects on firm-level innovative output.	Panel data

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Rothaermel, F. T., and M. T. Alexandre.	Ambidexterity in technol- ogy sourcing: The moderating role of absorptive capacity.	2009	Organization Science 20	Ambidexterity perspective. First must master exploration and exploitation when developing new product offerings.	Quantitative Analysis	Firm-level	Technology Sourcing	Performance	the relationship between technology sourcing mix and firm performance is an inverted U-shape. Moreover, higher levels of absorptive capacity allow a firm to more fully capture the benefits resulting from ambidexterity in technology sourcing.	470 US manufacturing firms from various industries.
Sandmeier, P.	Customer integration strategies for innovation projects: Anticipation and brokering.	2009	International Journal of Technology Management 48	Integrating customer contributions into new product development provides an effective approach for successful product innovation, but little academic research explicitly addresses appropriate customer integration strategies. To explore such strategies, this study investigates the impact of different customer contribution types and timing.	Qualitative analysis	Firm-level	Non-applicable		the careful selection of the customer integration strategy according to the company's industry establishedness and targeted degree of product newness is recommended. Keywords:	4 cases from Northern European firms
Schiele, H.	Early supplier integration: The dual role of purchasing in new product development.	2010	R&D Management 40	Interest in early supplier integration in new product development (NPD) has increased as an open innovation approach has become more common in firms. To support supplier integration, the purchasing function of a firm can assume a new 'dual' role: contributing to NPD while also managing overall costs. Previous	Qualitative analysis	Firm-level	Non-applicable		The findings describe how innovative firms organise their purchasing function, distinguishing between 'advanced sourcing' and 'life-cycle sourcing' units. The results include the tools that these firms use, such as regular innovation meetings with suppliers and technology roadmaps linking firm strategy, innovation strategy and sourcing strategies.	6 firms
Sieg, J. H., M.W.Wallin, and G. von Krogh.	Managerial challenges in open innovation:Astudy of innovation intermediation in the chemi- cal industry.	2010	R&D Management 40	The paper examines the the role of intermediaries in the R6D management process.	Qualitative analysis	Firm-level	Non-applicable		Three recurring challenges were identified in all companies: (1) enlisting internal scientists to work with the innovation intermediary; (2) selecting the right problems; and (3) formulating problems so as to enable novel solutions.	7 Chemical firms
Slowinski, G., and M.W. Sagal.	Good practices in open innovation.	2010	Research-Technology Management 53	Identifies 12 core best practices for using open innovation in organizations.	Qualitative analysis	Conceptual	Non-applicable		The development and management of relationships may be the most complex set of organizational activities carried out on a regular basis. Managers must coordinate and integrate the resources of two firms, each with different embedded processes and systems, each with for- mal and informal reporting structures, and do it in a market-relevant time frame.	Conceptual
Spaeth, S., M. Stuermer, G. von Krogh.	Enabling knowledge creation through outsiders: Towards a push model of open innovation.	2010	International Journal of Technology Management 52	Open innovation is increasingly being adopted in business and describes a situation in which firms exchange ideas and knowledge with external participants, such as customers, suppliers, partner, firms, and universities. This article extends the concept of open innovation with a push model of open innovation: knowledge is voluntarily created outside a firm by individuals and organisations who proceed to push knowledge into a firm's open innovation project.	Qualitative analysis	Platform	Non-applicable		Based on the insights from Eclipse, four propositions are presented: 'preemptive generosity' of a firm, 'continuous commitment', 'adaptive governance structure', and 'low entry barrier' are contexts that enable the push model of open innovation	Eclipse Software platform
Spithoven, A., B. Clarysse, and M. Knockaert.	Building absorptive capacity to organise inbound open innovation in traditional industries.	2010	Technovation 30	Small firms and firms,which operate in traditional sectors, engage in open innovation activities. The latter two categories of firms often dispose of no, or atmost a relatively low level of, absorptive capacity. Open innovation has two faces. In the case of inbound open innovation, companies screen their environment to search for technology and knowledge and do not exclusively rely on in-house R&D. A key pre-condition is that firms dispose of "absorptive capacity" to internalise external knowledge. SMEs and firms in traditional industries might need assistance in building absorptive capacity.	Qualitative & Quantitative analysis	Individual and firm-level	External knowledge, Networking activities, impact of collective research centers.		The paper demonstrates that the openness of the innovation process forces firms lacking absorptive capacity to search for alternative ways to engage in inbound open innovation. The paper highlights the multiple activities of which absorptive capacity in intermediaries is made up	856 individuals employed in Belgian firms. Drawn from a population of 80.000
Stam,W.	When does community participation enhance the performance of open source software companies.	2009	Research Policy 38	This study examined how participation in open innovation communities influences the innovative and financial performance of firms commercializing open source software. Using	Quantitative analysis	Firm-level	Community participation, R&D Intensity	Financial performance	found that the community participation performance relationship is curvilinear. In addition, results indicate that extensive technical participation in open source projects is more strongly related to performance for firms that also engage in social ("offline") community activities, for companies of larger size, and for firms with high R&D intensities.	125 firms

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Stuermer, M., S. Spaeth, and G. von Krogh.	Extending private-collective innovation:Acase study.	2009	R&D Management 39	The private-collective innovation model proposes incentives for individuals and firms to privately invest resources to create public goods innovations. Such innovations are characterized by non-rivalry and non-exclusivity in consumption. Examples include open source software, user-generated media products, drug formulas, and sport equipment designs. There is still limited empirical research on private-collective innovation.	Qualitative analysis	Firm-level	Non-applicable		Seven benefits for Nokia are identified, as are five hidden costs: difficulty to differentiate, guarding business secrets, reducing community entry barriers, giving up control, and organizational inertia.	Single case study
Teirlinck, P., M. Dumont, and A. Spithoven.	Corporate decision- making in R&D outsourcing and the impact on internal R&D employ- ment intensity.	2010	Industrial and Corporate Change 19	This article aims to assess whether firms' strategies of R&D outsourcing determine changes in their internal R&D employment intensity. Four strategic decisions are investigated: to start, increase, decrease or stop outsourcing.	Quantitative Analysis	Firm-level	Location, size, industrial activities	Corporate R&D outsourcing	internal R&D employment intensity decreases when firms decide to start, to increase, or to stop R&D outsourcing. However, this finding hides important differences according to the type and the location of the contractor. In general, firms prefer a mix of different types of contractors at different locations. Started outsourcing of R&D to research centers within the nation and increased R&D outsourcing to research centers within the region appear to decrease the internal R&D employment intensity. Decreasing outsourcing to national universities in another region also has a negative impact on internal R&D employment intensity.	384 enterprises
Terwiesch, C., andY. Xu.	Innovation contests, open innovation, and multiagent problem solving.	2008	Management Science 54	In an innovation contest, a firm (the seeker) facing an innovation-related problem (e.g., a technical R&D problem) posts this problem to a population of independent agents (the solvers) and then provides an award to the agent that generated the best solution. In this paper, this article analyzes the interaction between a seeker and a set of solvers. Prior research in economics suggests that having many solvers work on an innovation problem will lead to a lower equilibrium effort for each solver, which is undesirable from the perspective of the seeker.	Quantitative analysis	Conceptual	Expertise-based projects, Ideation-based projects, Trial and error projects. Market uncertainty, technology uncertainty.		The seeker can benefit from a larger solver population because he obtains a more diverse set of solutions, which mitigates and sometimes outweighs the effect of the solvers' underinvestment in effort.	Conceptual
Tether	Who co-operates for innovation, andwhy. An empirical analysis	2002	Research Policy 31	Patterns of cooperation in NPD.	Qualitative analysis	Firm-level	R&D and co-operation; Co-operation to reduce difficult in NPD; Type of innovation.	Co-operation with different partners.	Majority of firms still do NPD without formal collaboration. More likely if high levels of innovativeness involved,	1275 firms from the UK's version of the European community innovation survey (CIS-2).
Tether, B. S., and A. Tajar.	Beyond industry-university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base.	2008	Research Policy 37	This paper explores the use of specialist knowledge providers as sources of information in the innovation activities of manufacturing and service firms. Specialist knowledge providers are consultancies, private research organisations and the public science-base (i.e., universities and the government research laboratories). These may be engaged by firms in co-operative arrangement for innovation or as informal sources of information.	Quantitative Analysis	Firm-level	Manufacturing divided by industry, Openness, R&D, Radical innovation, incremental innovation, Specialist	Sources of information for innovation	amongst other factors specialist knowledge providers are more likely to be engaged by firms with more open approaches to innovation, those with high levels of absorptive capacity, those with greater social capital and networking capabilities, as well as by those with deeper commitments to innovation. Overall, the use of specialist knowledge providers tends to complement firms' own internal innovation activities and to complement other external sources of knowledge.Moreover, the individual types of specialist knowledge providers tend to complement rather than substitute for one another.	3996 reposents UK CIS
Tijssen, R.	Science dependence of technologies: evidence from inventions and their inventors	2002	Research Policy 31	The prime aim was to examine what actually happens in innovation practice through patent data.	Quantitative analysis	Firm-level & Industry-level	Internal knowledge; external R&D; Other information sources.	Patent data	The outcome confirms that several, more or less equally influential factors seem to be determining the knowledge creation and transfer processes leading to successful technical inventions. The type of organization and internal R&D environment are clearly the most significant determinants in the science dependence of its patented inventions. Internal sources are being used heavily for the development of invention ideas, where inventors often cite their own research and previous patents as important elements in the inventive process.	93 dutch firms, universities and research institutions.

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Un, C. A., A. Cuervo-Cazurra, and K. Asakawa	R&D collaborations and product innovation.	2010	Journal of Product Innovation Management 27	This paper studies the relative impact on product innovation of research and development (R&D) collaborations with universities, suppliers, customers, and competitors. It argues that each type of R&D collaboration differs in terms of the breadth of new knowledge provided to the firm and in the ease of access of this new knowledge, resulting in a different impact on product innovation. As a result, it proposes that R&D collaborations with universities are likely to have the highest impact on product innovation, followed by R&D collaborations with suppliers, customers, and, finally, competitors.	Quantitative Analysis	Firm-level	R&D collaboration with: Suppliers, customers, universities, Competitors, R&D intensity,	Product innovations	R&D collaborations with suppliers have the highest positive impact on product innovation, followed by collaborations with universities. Surprisingly, R&D collaborations with customers do not appear to affect product innovation, and collaborations with competitors appear to harm it. Moreover, the positive influence of R&D collaborations with universities and suppliers is sustained over the long- term, but the negative influence of R&D collaborations with competitors is, fortunately, short-lived. These findings indicate that ease of knowledge access, rather than breadth of knowledge, appears to drive the success of R&D collaborations for product innovation. R&D collaborations with suppliers or universities, which are characterized by relatively easy knowledge access, have a positive influence on product innovation, whereas R&D collaborations with customers or competitors, which are characterized by reduced ease in knowledge access, are not related or are even negatively related to product innovation. Moreover, to achieve product innovation with the help of R&D collaborations, it appears that the collaboration must first have mechanisms in place to facilitate the transfer of knowledge; once these are in place, it is better if the partner has a relatively narrow knowledge base.	781 manufacturing firms
Urban, G. and von Hippel, E.	Lead User Analysis for the Development of Industrial Products	1988	Management Science 34	this paper we integrate market research within this lead user methodology and report a test of it in the rapidly evolving field of computer-aided systems for the design of printed circuit boards (PC-CAD).	Quantitative analysis	Firm-level	Non-applicable, cluster analysis		In the test, lead users were successfully identified and proved to have unique and useful data regarding both new product needs and solutions responsive to those needs. New product concepts generated on the basis of lead user data were found to be strongly preferred by a representative sample of PC-CAD users.	136 respondents from the PC.-CAD industry
van de Vrande, V., J. P. J. de Jong, W. Vanhaverbeke, and M. de Rochemont.	Open innovation in SMEs: Trends, motives and management challenges. Technovation	2009	Technovation 29	This exploratory paper investigates if open innovation practices are also applied by small- and medium-sized enterprises (SMEs)	Quantitative Analysis	Firm-level	Technology exploration, technology Exploitation		No major differences between manufacturing and services industries, but medium-sized firms are on average more heavily involved in open innovation than their smaller counterparts	605 SMEs in the Netherlands
Vanhaverbeke, W., G. Duysters, and N. Noorderhaven.	External technology sourcing through alliances or acquisitions: An analysis of the application-specific integrated circuits industry	2002	Organization Science 13	In today's turbulent business environment innovation is the result of the interplay between two distinct but related factors: endogenous R&D efforts and (quasi) external acquisition of technology and know-how. Given the increasing importance of innovation, it is vital to understand more about the altemative mechanisms—such as alliances and acquisitions—that can be used to enhance the innovative performance of companies. Most of the literature has dealt with these altematives as isolated issues. Companies, however, are constantly challenged to choose between acquisitions and strategic alliances, given the limited resources that can be spent on research and develop- ment.	Quantitative analysis	Individual-level	Prior ties; Network distance, Inter-ties between actors, Network centrality	Choice between strategic alliance and M&A	The findings show that a series of strategic alliances between two partners increases the probability that one will ultimately acquire the other. Whereas previous direct contacts tend to lead to an acquisition, this is not true of previous indirect contacts, which increase the probability that a link between the companies, once it is forged, takes the form of a strategic alliance. In the case of acquisitions, firms that are more centrally located in the network of interfirm alliances tend to be acquirers, and firms with a less central position tend to become acquired.	140 mergers and acquisitions
Veugelers, M.	Internal R&D expenditures and external technology sourcing.	1997	Research Policy 26	The paper looks at the two-way relationship between R&D activities and internal R&D expenditure.	Quantitative analysis	Firm-level	R&D expenditure, size (sales), Industry characteristics.	Technology performance	R&D cooperation and to a lesser extent R&D contracted out are found to have a significant positive impact on R&D, but only if the firm has absorptive capacity through a full time R&D department.	290 Flemish firms.
von Hippel, E.	Horizontal innovation networks—by and for users.	2007	Industrial and Corporate Change 16	Innovation development, production, distribution and consumption networks can be built up horizontally—with actors consisting only of innovation users (more precisely, “user/self-manufacturers”). Some open source software projects are examples of such networks, and examples can be found in the case of physical products as well. In this article, three conditions under which user innovation networks can function entirely independently of manufacturers are discussed.	Qualitative analysis	Firm-level	Non-applicable		We have now seen that conditions favorable to horizontal, user innovation networks may exist in many fields. That is: users do frequently innovate in many fields, and these users appear to often have the incentives to freely reveal innovation-related information and means for innovation replication and distribution that are cost-competitive with those available to manufacturers as well. In this article, The focus is on exploring why users in particular might innovate and then freely reveal their proprietary information on user innovation networks rather than attempt to hide or license that information.	Anecdotal evidence
von Hippel, E.	Lead Users: A Source of Novel Product Concepts	1986	Management science 32	Lead users are users whose present strong needs will become general in a marketplace months or years in the future. Since lead users are familiar with conditions which lie in the future for most others, they can serve as a need-forecasting laboratory for marketing research. Moreover, since lead users often attempt to fill the need they experience, they can provide new product concept and design data as well.	Qualitative analysis	Conceptual	Non-applicable		This paper identifies lead users, and explored the valuable insights they can offer regarding needs—and, often, prototype solutions—for novel products, processes and services.	Conceptual

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Weerd-Nederhof, P. De, & Fisscher, O.	Alignment and Alliances for Research Institutes Engaged in Product Innovation. Two Case Studies	2003	Creativity and Innovation Management 12	The focus of this paper is the analysis of research institutions taking the lead in a network of partners engaged in NPD.	Qualitative analysis	Institutional and Network level	Non-applicable		Alignment between research institutions and partners during product innovations are liked to operational effectiveness and strategic flexibility.	2 case studies
West, J.	How open is open enough? Melding proprietary and open source platform strategies.	2003	Research Policy 32	Responding to the Internet and open source systems, three traditional vendors of proprietary platforms experimented with hybrid strategies which attempted to combine the advantages of open source software while retaining control and differentiation. Such hybrid standards strategies reflect the competing imperatives for adoption and appropriability, and suggest the conditions under which such strategies may be preferable to either the purely open or purely proprietary alternatives.	Qualitative analysis	Firm-level and network-level	Non-applicable		Open source standards differ from other unsponsored open standards mainly in degree, to the extent that the entry and imitation barriers are dramatically lower. But the idea of a shared standard— with the associated implications for governance and differentiation. To a lesser degree, hybrid platform strategies have existed for decades, driven by the ever-increasing need for systems interoperability between or within organizations.	5 software plaforms
West, J., and Bogers, M.	Leveraging External Sources of Innovation	2013	Journal of Product Innovation Management 31	An overview of the development in open innovation literature.	Qualitative analysis	Conceptual	Non-applicable		This review and synthesis suggests several gaps in prior research. One is a tendency to ignore the importance of business models, despite their central role in distinguishing open innovation from earlier research on interorganizational collaboration in innovation. Another gap is a tendency in open innovation to use "innovation" in a way inconsistent with earlier definitions in innovation management. The	literature review
West, J., and S. Gallagher.	Challenges of open innovation: The paradox of firm investment in open-source software. R&D	2006	R&D Management 36	This article identifies three fundamental challenges for firms in applying the concept of open innovation: finding creative ways to exploit internal innovation, incorporating external innovation into internal development, and motivating outsiders to supply an ongoing stream of external innovations. This latter challenge involves a paradox, why would firms spend money on R&D efforts if the results of these efforts are available to rival firms	Qualitative analysis	Firm-level	Non-applicable		The article identifies four strategies firms employ – pooled R&D/product development, spinouts, selling complements and attracting donated complements – and discuss how they address the three key challenges of open innovation.	41 informants from 26 organizations
Whelan, E., R. Teigland, B. Donnellan, and W. Golden.	How Internet technologies impact information flows in R&D: Reconsidering the technological gatekeeper.	2010	R&D Management 40	Previous studies have firmly established the technological gatekeeper to be a key node in the innovation process – acquiring, translating, and disseminating external information through- out the R&D unit. However, the gatekeeper concept has received modest attention in recent times. The article argue that the concept needs to be re-examined in light of the recent advances in Internet technologies that have dramatically altered how knowledge workers source and share their information. Drawing	Quantitative Analysis	Network-level, in single firm	R&D group member, external star, internal star, Gatekeeper		This study suggested that the technological gatekeeper may no longer exist in R&D settings due to the recent advances in Internet technologies that enable knowledge workers to easily access and disseminate information of emerging technological developments.	Single case study
Wincent, J., S. Anokhin, and H. Boter.	Network board continuity and effectiveness of open innovation in Swedish strategic small-firm networks.	2009	R&D Management 39	Increasing adoption of open innovation as an alternative route to research and development necessitates the development of new ways to organize innovation, as well as reassessment of existing ways. Much like traditional corporations that subscribe to the closed innovation paradigm, novel organizational arrangements targeting open innovation, such as small-firm networks, employ boards to effectively manage joint research-and-development activities. These boards are similar yet different from traditional corporate boards; as such, they may have different requirements for proper functioning.	Quantitative Analysis	Firm-level	Network board continuity	Innovation performance	corporate board composition principles indeed require careful reconsideration before being transplanted into the network board context.	53 Swedish SMEs
Witzeman, S., G. Slowinski, R. Dirkx, L. Gollob, J. Tao, S.Ward, and S. Miraglia	Harnessing external technology for innovation.	2006	Research-Technology Management 49	Companies continuously seek to innovate more quickly and more effectively both within and often beyond their core markets and product lines. This has resulted in the practice of "open innovation" wherein firms recognize that all components of an innovation do not need to come from within, that they can accelerate their own efforts or perhaps even broaden the scope of these efforts by acquiring some of the required technology externally. Research	Qualitative analysis	Firm-level	Non-applicable		Harnessing external technology for innovation requires a fundamental change in employee thinking. The "Not Invented Here" syndrome is replaced with the "Invented Anywhere" approach. Managers responsible for collaborative projects learn to share power and control with their counterparts in the partner firm. However, change brings friction. In an environment of off-shoring and out- sourcing, some employees may resist if they believe external firms are doing their jobs. However, more and more employees are embracing open innovation. They see the benefits of utilizing a world of resources and benefit from the resulting growth.	25 case study

Author	Title	Year	Publication	Central Topic of Research	Research Methodology	Level of Analysis	Relationship Studied		Key Findings	Sample Size
							Independent Variable	Dependent Variable		
Zahra, S. A., and G. George.	Absorptive capacity: A review, reconceptualization, and extension.	2002	Academy of Management Review 27	Researchers have used the absorptive capacity construct to explain various organizational phenomena. In this article we review the literature to identify key dimensions of absorptive capacity and offer a reconceptualization of this construct. Building upon the dynamic capabilities view of the firm, this article distinguish between a firm's potential and realized capacity.	Qualitative analysis	Conceptual	Non-applicable		this article provides a foundation for future work using ACAP, based on three primary contributions. First, by reviewing prior research and delineating four dimensions, we define and clarify the dimensionality of this complex construct and the dimensions' respective roles and importance. Second, the distinction between PACAP and RACAP suggests that externally acquired knowledge undergoes multiple iterative processes before the recipient firm can successfully exploit it to achieve a competitive advantage.	Conceptual
Zeng, S. X., X. M. Xie, and C. M. Tam.	Relationship between cooperation networks and innovation performance of SMEs.	2010	Technovation 30	The complexity of innovation processes led to a tremendous growth in the use of external networks by small- and medium-sized enterprises (SMEs). Based	Quantitative Analysis	Firm-level	Firm cooperation, Cooperation with other agencies, Innovation performance,		The study finds that there are significant positive relationships between inter-firm cooperation, cooperation with intermediary institutions, cooperation with research organizations and innovation performance of SMEs, of which inter-firm cooperation has the most significant positive impact on the innovation performance of SMEs. Surprisingly, the result reveals that the linkage and cooperation with government agencies do not demonstrate any significant impact on the innovation performance of SMEs. In	137 Chinese Manufacturing firms

DTU Management Engineering
Department of management engineering
Danmarks Tekniske Universitet

Technology and Innovation Management
Diplomvej 372
2800 Kgs.Lyngby

www.tim.man.dtu.dk