2018 | Faculty of Business Economics

UHASSELT

KNOWLEDGE IN ACTION

Doctoral dissertation submitted to obtain the degree of
Doctor of Business Economics, to be defended by

Marek Vaculik

DOCTORAL DISSERTATION

New product development, organizational learning and open innovation activities: vehicles for a continuous organizational renewal

D/2019/2451/1

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ACKNOWLEDGEMENT

This dissertation owes its existence to a personal quest for exceeding and extending limits, and I am indebted to several persons who have played a decisive role in various ways along the journey of this project. To them all, I am more than grateful.

Particularly, I would like to express my gratitude to my promoter Prof. Wim Vanhaverbeke who have introduced me to management research and fuelled my interest in this topic back in the days of my studies at the Hasselt University. During my time as a PhD student, I received very valuable inputs from Dr. Annika Lorenz and Prof. Nadine Roijakkers who supported and challenged me in professional as well as personal ways. I'm personally indebted to them as they heavily influenced my perspective about what management research really means and how it should be conducted.

I would like to thank the director of TESCO SW company, Josef Tesařík for his patience and the possibility to handle my study and professional responsibilities.

This thesis would not exist without the support and love of my wife Zuzana. She sacrificed a great deal of time not spent together, and she always provided me with understanding and patience. This work not only took a PhD leave of absence from my job, but also parts of two parental leaves following the arrival of our two sons Vojtěch and Jindřich, not to forget several holidays and week-ends dedicated to this project.

Marek Vaculík

Olomouc, December 2018

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1 INTRODUCTION

When characterizing today's market economy, we continually hear the same adjectives, such as "turbulent", "dynamic", "disruptive", "unpredictable", etc. All these labels have something in common; they reflect a dominant feature of our times – the rapidly changing business environment. There are many factors causing this situation: technological advances, unconstrained financial flows across countries, the increasing number and mobility of knowledge-intensive workers and changing customer preferences are among the most prominent ones.

Both individuals and organizations need to adapt to this ever-changing landscape in order to generate sustainable growth and profit. The inability of an organization to keep up with the changes in its environment and/or to search proactively for new opportunities may lead to its faster or slower demise. Recognizing this challenge, researchers have been analyzing practices and searching and examining theories and models in the area of organizational renewal[1] in an attempt to help organizations to create alignments with the turbulent external environment and gain competitive advantages on a sustainable basis in the long run (Barr et al., 1992; Brown & Eisenhardt, 1995; Volberda et al., 2001).

I will focus on this phenomenon from two perspectives; I see open innovation activities and new product development as instruments of organizational renewal. I believe that the connection of three theoretical streams – organizational innovation, open innovation and new product development - makes a significant contribution to theory as well as managerial practice. These three topics are discussed in the subsections below.

1.1 ORGANIZATIONAL RENEWAL

The theme of organizational renewal has been a matter of research interest for a long time. According to Agarwal and Helfat (2009) it *includes the process, content, and outcome of refreshment or replacement of attributes of an organization that have the potential to substantially affect its long-term prospects"* (p. 282). Floyd and Lane (2000) defined organizational renewal as a *process*

[1] I use the term as a synonym for strategic renewal.

*associated with promoting, accommodating, and utilizing new knowledge and innovative behaviour in order to bring about change in an organization's core competencies and/or a change in its product market domain (*p. 155)*.* Different studies defined it as the activities a firm undertakes to alter its path dependence (Volberda et al. 2001), the outcome of the interaction of stress and inertia (Huff et al., 1992), and the *"alignment of organizational competencies with the environment"* (Flier et al., 2003, p. 2168). As such it differs from more general concept of strategic change as it refers only to a specific type of strategic change – *the transformation of the firm's current strategic intent and capabilities* (Schmitt et al., 2016, p. 6).

Organizational renewal has evolved into a distinct research concept and has been used by researches active in areas of (1) corporate entrepreneurship (e.g. Zahra 1993; Stopford & Bade-Fuller, 1994; Sharma & Chrisman, 1999) where it has been associated with the study of renewal of established organizations in contrast to corporate venturing activities which focus mainly on the birth of new businesses; (2) strategic process research which identified the concept with evolutionary models of strategic change (e.g. Burgelman, 1991; Floyd & Lane, 2000; Huff et al., 1992) where organizational renewal is linked to changes in core competences and strategic positioning; and (3) dynamic capabilities (e.g. Agarwal & Helfat, 2009; Augier & Teece, 2009; Capron & Mitchell; Salvato, 2009) which highlights the need to incorporate both *process* as well as *content* aspects of organizational renewal. In this context Riviere & Suder (2016) argue that to *renew capabilities* through search and learn routines is a most important capability for sustained performance.

Agarwal & Helfat (2009) distinguish between two basic types of organizational renewal – *discontinuous strategic transformations* and *incremental renewal*. Advocates of the discontinuous perspective base their assumptions on the technology cycles theory, arguing that relatively stable periods of incremental innovation are ruptured by technological discontinuities – rare, unpredictable events initiated either by scientific advances or by a unique combination of existing technology (Tushman & O'Reilly, 1996). These abrupt changes trigger turbulent periods of technological and competitive ferment which are closed by the emergence of an industry standard or dominant design, followed again by a

relatively stable period of incremental change (Tushman & Anderson, 1986). And it is actually here at the point of relatively stable market conditions that for many organizations a threat hides which makes them vulnerable in terms of future profitability. The threat is embodied in the ossification of the core capabilities that were once responsible for bringing new products on the market but now turn into rigidities choking any creative processes and bringing about a timeless state of inertia (Leonard-Barton, 1992). Here small, incremental changes are not sufficient. To foster renewal, leaders must push through changes forcefully so that organizations can move quickly away from their old heritage and meet changing demands. System-wide organizational transformations need to be executed if the organization is to survive (Tushman et al., 1997).

In the light of this view, models such as skunk works (Fosfuri & Ronde, 2009), business process reengineering (Hammer, 1990), cross-functional product development teams (Sethi et al., 2001), and employee involvement (Morgan & Zeffane, 2003) have been widely applied in attempts to respond rapidly to external pressures and/or gain first mover competitive advantages.

Proponents of the second (incremental) perspective argue that revolutionary change is not sustainable because organizations need stability to learn and operate efficiently (after abrupt changes have occurred, firms often lapse back to a stable state). It is believed that renewal should be a gradual, continuous process in which all members of the organization are committed to continuous improvements, learning, and adaptation. Managers should lead renewal by providing guidance and creating a suitable environment as opposed to commanding actions (Helfat & Martin, 2014). Continuous, evolutionary organizational development implemented gradually in a longer timeframe should be pursued instead of complex and abrupt transformation. Scholars in this literature stream focus mainly on problem-solving improvements, working through conflicts, team effectiveness, interpersonal competence, managerial skills, leadership, decision-making processes, communication, and so on.

In this dissertation I take the view that the self-renewal ability implies that organizations are able to evolve constantly as a result of proactively searching for and utilizing of new knowledge and innovative activities in order to recombine their core competencies and/or make changes in their product market domain

(Floyd & Lane, 2000). But such a change never comes easily as strong and enduring inertial forces exerted by ossified competencies are difficult to overcome. The organization's structures, procedures, and relationships continue to reinforce prior patterns of behaviour and to resist new ones. As a result, organizational innovations sometimes result in upheavals and dissatisfaction, and possibly even in resignations, dismissals, or indifference (Hedberg et al., 1976). The tension between maintaining the status quo and the need to change is actually the focus of this work.

Despite such theoretical and conceptual advancements, a key focus of prior research was on the underlying environmental antecedents and processes of organizational renewal. While we have also gained insights in intermediate process outcomes of renewal, only a limited number of studies have directly and empirically investigated the associations between organizational renewal and new product development (Danneels, 2002; Kim & Pennings, 2009; Tripsas, 2009). Moreover, there is no analysis within organizational renewal research that has empirically studied the relationship between firm-level determinants of innovation project termination and organizational renewal. Learning from failing appears to be a valuable learning opportunity as it improves the chances of successful future innovation. By analysing the learning capabilities (with regard to innovation project termination) this dissertation permits to link the study of dynamic capabilities view in organizational renewal research with organizational learning perspective.

We also lack empirical analysis that study different modes of organizational renewal, for example associated with choices between internal and external renewal actions. To analyse and integrate these shortcomings of previous research, this dissertation explores the relationships between a firm's competency base and innovation activities, which are perceived as an engine of the organizational renewal process (Bowen et al., 1994). I see the renewal process as an antidote to inertia and rigidity. But what are the triggers and factors that cause and consequently enhance the process? Many researchers have pointed out that the main ones are new product development, the exploration of new business opportunities and of knowledge outside the firm's boundaries, opening up of the innovation process, experimentation, etc. All in all I can generalize that the main

engine is the innovation activities that cause the momentum for change to gather. As a result of innovation activities managers are not at the mercy of external events but they are empowered to actively influence and cultivate their environment.

But the ability to innovate is not something everybody possesses. It is necessary to have the right people, technology, and processes in place. To put it another way, it is necessary to have the right competencies for innovation. As suggested earlier, without continuous recombination these competencies will one day turn into rigidities. To prevent that from happening a company needs to start the whole innovation process in such a way that it involves a series of fresh beginnings.

1.2 OPEN INNOVATION

As indicated above, innovation activity is a natural precondition for continuous renewal. In recent decades the innovation domain (in the academic as well as the practical sense) has undergone a significant shift from the 'closed innovation' paradigm, where companies rely on internal capabilities, towards the 'open innovation' model (Chesbrough, 2003), using a wide range of inter-organizational ties and sources (Laursen & Salter, 2006). This transition has been enabled by several factors identified by Chesbrough (2003). Here I will present only the two most important ones. First, the availability and mobility of a skilled workforce and the widespread use of IT technologies has facilitated knowledge distribution among many actors. Second, the growth of the venture capital market has released enormous investments into various start-ups and business models considered risky by traditional banks and investors. Venture capital has indeed supported and nurtured a significant number of new ideas and projects which would otherwise not have seen the light of day. These factors, accompanied by others (e.g. unused IP), have undermined the role of traditional R&D units as the sole source of knowledge. After an era of centralized R&D activities companies have refocused on external sources of innovation in order to yield swifter results from innovation and improve efficiency (Gassmann et al., 2010).

It is exactly these purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for the external use of innovation that have been termed "open innovation" (Chesbrough, 2003). This differs from the

traditional innovation model in many ways. Closed innovation companies innovate by using only internal resources, and usually during the innovation process ideas are evaluated and only the best and most promising ones are selected for development and commercialization. The ones that show less potential are abandoned. The difference between open and closed innovation is that in the case of closed innovation the ideas and developments are generated within the company. However, when applying open innovation, the company can use external resources such as technologies and creative ideas and at the same time make its own innovations available to other organizations.

Under the open innovation paradigm there is an important flow of external knowledge into the organization which turns into collaborative projects with external partners and leads to the purchase and integration of external technologies. At the same time, the innovations generated within the company can be sold as technology and/or industrial property to other organizations since either they are not applicable within the company's business model or because the company has no capacity or experience to turn them into products. The final result is that some products reach the market by using exclusively internal resources from the initial idea up to the commercialization of the final product. Other products are the result of incorporating external knowledge at different stages of their development.

Since its inception open innovation has aroused enormous interest and has become an en vogue topic for both research and management. It is widely acknowledged that internal knowledge resources are not enough for continuous product innovation and if a company wants to stay ahead of the innovation peloton it should enrich its knowledge portfolio by external knowledge sources, e.g. universities and R&D labs, competitors, customers, and other users outside the firm who are an important source of valuable innovations (von Hippel, 2005).

What has been less clear and has attracted the interest of academia only lately is the fact that the search for external knowledge needs to be accompanied by effective transfer and diffusion within the organizational boundaries. To do this, firms need to develop complementary internal networks (Hansen & Nohria, 2004) and structures that integrate external knowledge into the firm's innovation process (Chiaroni et al., 2010, 2011). As with other processes, it needs to be

planned, coordinated, and assessed. Then the right set of procedures and sub-processes has to be put in place.

Organizations require a capacity for partnership that will increase their innovative performance (Lichtenthaler & Lichtenthaler, 2009). It is about selecting the right partner, integrating the knowledge of the partner, and the right form of collaboration for a given initiative. The open innovation process needs to be facilitated using internal processes, structures, systems, and tools. Putting the right processes in place could affect the efficiency of open innovation projects (e.g. the time-to-market of a product idea could be shortened). So the question is how to take maximum advantage of open innovation through mechanisms inside and outside the organization (Enkel et al., 2009). Once adopted, the open innovation paradigm means a shift from intra-firm interfaces to complex inter-firm relations, to webs of interdependence with partners and potentially anonymous communities (Tushman et al., 2012).

In sum, opening up a firm's boundaries refers to the process of introducing new forms of external relationships with other companies or institutions (e.g. alliances, customer relationships, supplier integration). Thus it refers to a change in how a firm navigates the external environment and reaches out to external partners. As stated above, a firm does not usually possess all the necessary know-how in-house to successfully develop and/or commercialize new products, services, or processes. Hence, a firm needs to regularly obtain new input and ideas from outside to enhance its own capabilities and to be able to fully exploit the potential of, and manage, technological innovation activities.

1.3 NEW PRODUCT DEVELOPMENT

Here I take a view of strategic adaptation and continuous change which perceives firms as proactive actors in the process of organizational change[2] rather than passive objects of an environmental selection process. This implies that firms are able to constantly evolve as a result of proactively searching for and utilizing new knowledge and innovative activities in order to recombine their core competencies and/or make changes in their product market domain (Floyd & Lane, 2000). Product innovation is then a vehicle for the adaptation process. That is why Bowen et al. (1994) labelled development projects as "*agents of change*" (p. 111) because if companies pursue sustained product innovation they must fundamentally change how they organize (Dougherty & Hardy, 1996). This is also true for the shift towards open innovation which I described above, and so I understand the new product development process as a field that combines organizational innovation and open innovation perspectives. This is a novel approach as I examine the simultaneous use of open innovation and organizational innovation in improving innovation performance of companies. This is an unexplored research topic with a potential to substantially enrich the field of new product development research.

The "renewal" attribute within NPD is obvious as to change the current product path dependency the firm has to reinvent the processes that govern management work (Hamel, 2006). As such, product innovation efforts need to be accompanied by organization-wide changes; otherwise they have a higher chance to be prone to failure (Dougherty & Cohen, 1995). This has also been confirmed by Damanpour & Evan (1984), who showed that the adoption of administrative innovation facilitates the adoption of technical innovation.

There exists a mutual interdependence, as changes in the organizational arrangements (either in the internal procedures or external relationships) of a firm

[2] By "*organizational change*" I mean more general concept stemming from sociological research on the organizational change process and environment-organization relations. Defining the "*change*" as "*an empirical observation of difference in form, quality, or state over time in an organizational entity*" (van de Ven & Poole, 1995). I distinguish this concept from more specific "*organizational innovation*" (used widely in this thesis), which is only one type of change describing the implementation of an organizational method (into a firm's practices, workplace, and/or external relations) which has not been used in the firm before and which is an outcome of a strategic choice made by the management.

should reflect the needs in the new product development domain. It means that if the internal decision-making procedures and organizational structure are in line with product innovation processes but there is a lack of formal and informal ties with external partners (either science-based or market-based) it could have dire consequences for innovativeness. Or, vice versa, when there are many external relationships with a continuous inflow of new ideas and knowledge but internal procedures are not adapted to this situation, then this would lead to poor product innovation management and ultimately to lower innovation performance. In this sense I would like to emphasize that organizational innovations should be thoroughly planned, implemented step by step and continuously evaluated in order to avoid friction within the organizational structure, because abrupt changes could lead to employee upheaval and dissatisfaction.

There is an important stream of literature on NPD showing the success and failure factors of an innovation project. Most of it shows that it is determined by a combination of factors rather than by any single factor. For example, Tadisina (1986) identifies 23 variables grouped into five categories, namely: uncertainty at initiation; pressure to start a project; expected impact; the areas of science and technology, and the intention to protect project outcomes. Balachandra (1996) groups the determinants into seven categories, namely: strategic; economic; environmental; technological; operational; behavioural, and organizational. Rubenstein et al. (1976) classify the variables into six categories as follows: factors related to impetus for innovation; factors related to project decision; factors related to project structure and process; factors related to organizational structure and process; factors related to outcomes, and other factors (van der Panne et al., 2003). Raelin and Balachandra (1985) found that the strategic parameters of a high-technology research environment (such as high rates of product turnover, high market share, and small size) lead to continuations, whereas infancy-stage product life cycle lead to terminations. Holzmann (1972) argues that innovation projects should be terminated when they are proven technically unfeasible or economically unsound. Furthermore, Balachandra (1996) investigates the determinants of innovation project termination in an international context and finds a remarkable consistency across

a set of 27 factors discriminating between successful and failing R&D projects in Japan, the UK, the USA, and Germany.

Establishing effective and flexible screening mechanisms to distinguish successful from potentially unsuccessful innovations can save a considerable amount of money and hence improve overall performance. That is why I argue in this thesis that the termination of innovation projects is a laudable management practice and the effective detection of such failures is necessary in order to avoid waste of time and high costs in continuing projects. Even if an innovation fails, responding to and managing such failure appears to be a valuable learning opportunity – and this improves the chances of successful future innovation. This learning from innovation termination creates the foundations for managing innovation efficiently and successfully. Particularly in cases of low (R&D) productivity and high late-stage attrition rates, what are termed 'quick-kill' strategies promote fast learning curves as they seek to bring forward decisions to terminate projects to an earlier point in the process.

1.4 INTEGRATING THE PERSPECTIVES

I have visualized the complex relationships between the environment, innovation processes, and competence base in Figure 1. I see the organizational renewal process mainly through the prism of constant tension between the competence base, which enables a company to innovate and consequently to adapt to the external environment. At the same time there is a clear feedback loop as the environment is dynamic and firms require new products quickly: therefore, there is a need to develop new products and to experiment with technology, cooperation, organizational forms, etc., which create pressure for competence recombination (McGrath, 2013). The relationships are self-reinforcing and dialectical as the organization influences the environment through the pace of its innovation activities and the environment influences the organizational mechanisms, processes, etc. so as to be productive and efficient. So there is not a typical causal relationship but rather mutually interlinked processes that influence and strengthen each other.

Firms in today's ever more complex and fast-changing business world need dynamic capabilities – in contrast to ordinary capabilities – so as to be able to react quickly and flexibly to internal and external changes. Hence, the dynamic

capabilities of a firm represent an essential element of innovation process management. As discussed above, innovation management requires timely and flexible decision-making to address rapidly changing environments. In inherently uncertain situations, such as in innovation processes, dynamic capabilities represent a new approach to managing deep (unqualifiable) uncertainty. Dynamic capabilities relate closely to the management's capability to effectively coordinate and redeploy internal and external competences (McGrath, 2013). Coupled with a validated strategy, dynamic capabilities enable an organization to change in a manner that supports evolutionary fitness and sustainable competitive advantage. A company should not just be focused on control and oversight, but on thinking creatively about new projects and business opportunities and executing them proficiently. The termination of an ongoing activity requires agile and fast reactions to unforeseen or unexpected change and has thus been discussed in the context of dynamic capabilities (Teece et al., 1997, 2007; Winter, 2003; Eisenhardt & Martin, 2000). In particular, innovation termination entails a transformational culture and strong leadership that can realign tangible and intangible assets, strategy, structure, and processes.

Moreover, dynamic capabilities are not only beneficial in dealing with innovation termination; they can also be enhanced by the termination of innovation activities. In turn, not developing dynamic capabilities after the discontinuation of innovation activities can also be detrimental for the recovery, profitability, and survival of a firm after experiencing such a situation.

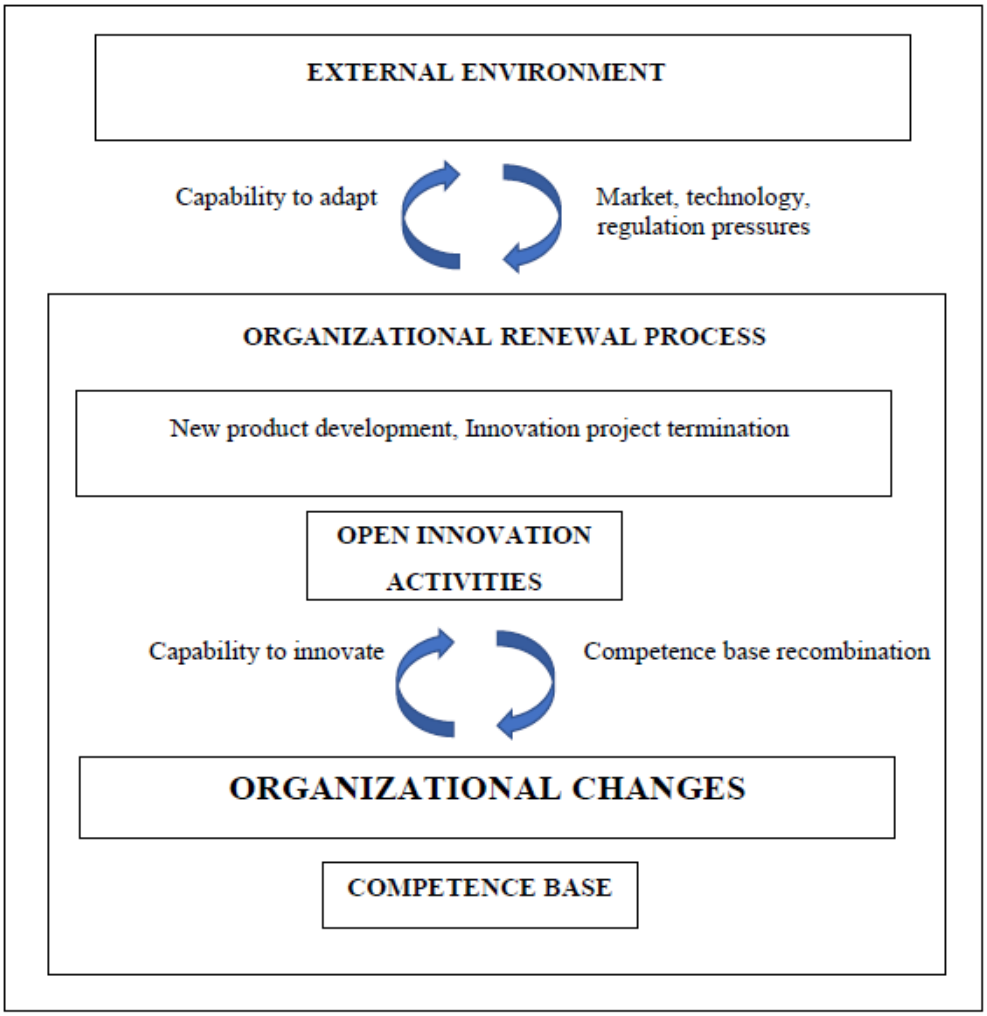


Figure 1: Organizational renewal proces.

Main research question

This dissertation targets to advance our knowledge by answering the following main research question: *What are the firm-level determinants of innovation performance measured by product innovation and innovation termination from open innovation point of view?* In answering this question, I break it down into several sub-questions in each empirical chapter.

1.5 STRUCTURE OF THE THESIS

The thesis is structured in such a way as to theoretically develop and empirically test the role of NPD and open innovation as instruments of organizational renewal as visualized in the model shown in Figure 1. I start by briefly presenting different concepts and their potential integration. After the introduction I follow with Chapter 2, which elaborates on the data used to perform the analyses. In particular I discuss the Community Innovation Survey 2010 and provide a breakdown of the sample and sub-samples on which the analyses are based. Then I describe and discuss the dependent, independent, moderating, and control variables used in the empirical chapters of the study and appropriate methods for analyses.

The data section is followed by three empirical chapters. Chapter 3 investigates the relationship between organizational and technological innovations, with a particular focus on whether there are any differences in the organizational innovations required for both radical and incremental product innovation in the manufacturing and service industries. The research question in this chapter states: *Are organizational innovations of a firm (particularly introduction of new internal procedures) and open innovation activity (measured by methods of organising external relations) associated with innovativeness of a firm (measured by product innovation)?* To examine the relationship between organizational innovation and product innovation empirically I analyse firm-level data from the cross-sectional Community Innovation Survey 2008-2010 for the Czech Republic (CIS 2010). The survey covered manufacturing as well as service firms. In total 5,151 responses were received. On the basis of that I distinguish between two measures of organizational innovation believed to play a role in increasing the probability of introducing new products onto the market,

particularly changes in internal organizing procedures and new ways of organizing external relations. Moreover, I analyse the effects of the organizational innovations on the probability of product innovation using four sub-samples that distinguish between new-to-the-market and new-to-the-firm innovative companies and between companies introducing new goods and new services onto the market. I also look closely at the interaction effect of the two organizational innovation measures. In exploring these issues the chapter provides fresh empirical evidence of the relationship between organizational innovation and the innovativeness of the firm. The results show that for successful product innovation both organizational innovations in internal procedures, as well as the need to reach out to external partners, are important in the manufacturing and service industries. Moreover, these changes are positively associated with both incremental and radical product innovations.

Chapter 4 deals with the firm-level determinants of innovation project termination. Firms need to innovate and develop dynamic capabilities to create a sustainable competitive advantage. Due to this pressure, firms in high-tech industries invest a high percentage of their revenues in innovation. Despite the vast number of innovation success stories, only one in five innovation projects reaches the market. It is important to understand the drivers of project termination as many firms make sizable investments in innovation and these drivers may have a significant impact on their innovation performance. Therefore, the earlier recognition of unfeasible projects would avoid continued investment and release resources that could be invested in more profitable projects. This chapter investigates firm-level factors determining the termination of innovation projects based on a sample of 4385 firms in the Czech Republic and Germany. The research question of this chapter is: "*What are the firm-level factors determining the termination of innovation endeavors by firms?*" I find that firm size, research and development activities, organizational innovation, and the level of internationalization are positively associated with innovation project termination. Surprisingly, marketing innovation is also positively associated with project termination. The results contribute to an improved understanding of why some firms are better at identifying unsuccessful projects (earlier) than others. Identifying generalizable factors provides complementary insights into project-

level factors of project termination that can have a remarkable impact on the profitability and survival of firms.

In Chapter 5 I focus on the conditions under which open innovation works and those under which it does not work. In this chapter I study the moderating effects of organizational innovation and absorptive capacity on the relationship between open innovation and innovation performance. I conceive of openness as interfirm exchanges with different partners directed towards innovation. The research question I will answer in this chapter is: "*What impact do organizational innovation and absorptive capacity have on the relationship between open innovation practices and the innovation performance of a firm*?" In this chapter, my aim is to accomplish two objectives: (1) to shed light onto whether organizational innovation and absorptive capacity augment or weaken the positive effect of open innovation on innovation performance and hence (2) whether either of the two variables enhances the positive effects of open innovation practices on innovation performance. For this study, I use the German and Czech Community Innovation Survey 2010 (CIS 2010), resulting in 10,721 firm observations, to understand their innovation behaviour and, specifically, the relationship between innovation cooperation, innovation performance, organizational innovation, and absorptive capacity. As a result of my research, firms can apply best practices concerning if and how to adapt their internal processes when entering into open innovation. I find that there is a pronounced effect of open innovation activities on innovation performance measured by percentage of total turnover in 2010 from innovative products. Interestingly, the findings show that absorptive capacity has its own positive effect on innovation performance, but it levels off the effect of open innovation up to a level that at the highest level of openness absorptive capacity doesn't have any impact on innovation performance. Absorptive capacity is thus a substitute for open innovation in improving the innovativeness of firms. I find similar results for organizational innovation which is also a substitute for open innovation in improving the innovativeness of firms. This research contributes to the literature studying open innovation by providing boundary conditions for the open innovation-performance relationship. Moreover, I study the boundary conditions of open innovation through coupling it with organizational innovation processes (Teece, 2007; Teece, 2009) and absorptive capacity (Cohen

& Levinthal, 1990). In doing so, I raise the awareness of researchers and practitioners about adapting or maintaining internal processes and methods of organizing external relations as an additional reinforcing source of innovation project performance.

Finally, in the conclusion I provide an overview of the findings and whether I have actually achieved the aims and research questions. Another important aspect is the presentation of managerial implications and further research topics, which await further exploration.

2 SAMPLE AND METHODS

2.1 INTRODUCTION

In this chapter I briefly elaborate on the data used to perform the empirical analyses. In particular, I discuss the Community Innovation Survey 2010 and provide a breakdown of the sample and sub-samples on which the analyses are based. Thereafter I describe the main characteristics of the dataset, followed by a detailed overview of the dependent, independent, moderating, and control variables used in the empirical chapters of the study and the statistical methods employed for data analysis.

2.2 COMMUNITY INOVATION SURVEY (CIS)

CIS is a survey conducted by the national statistical offices of particular EU states plus Norway and Iceland. The European Statistical Office prepares a questionnaire for all participating countries, so the data can be analysed uniformly across all states. On the other hand, some of the countries use their own questionnaire, which is only partly based on the Eurostat model. The design of the questionnaire stems from the Oslo Manual, which outlines the purpose of collecting information about innovation and defines how to select representative samples of companies divided according to different types of innovation. It also defines the basic terminology (e.g. "product innovation", "research and development", etc.).

The first Oslo Manual was created in 1992 at the same time as the first survey CIS1. But this first study had a number of shortcomings. However, the data from CIS1 showed that the EU was capable of creating full-featured and comparable data across member states in the coming years. The first three CIS surveys were not published at regular intervals. The second CIS study took place in 1996 and was introduced with the second version of the Oslo Manual (1997). The third survey took place in 2001. Subsequent surveys were introduced every two years. The reference year for CIS 4 was 2004, followed by CIS2006, CIS2008, and the latest versions, CIS2010 and CIS2012.

Table 1: CIS and Oslo Manual versions

Oslo Manual version 1	**Oslo Manual version 2**			**Oslo Manual version 3**			
CIS1 (1992)	CIS2 (1996)	CIS3 (2001)	CIS4 (2004)	CIS2006	CIS2008	CIS2010	CIS2012

CIS focuses on innovation from two sides. On the one hand, innovations include technical or technological innovations, which are described as product and process innovations. These innovations are focused on creating new or significantly improved goods or services in the case of product innovation. A process innovation means the implementation of a new or significantly improved production process. On the other hand, non-technical innovations include marketing and organizational innovations. Marketing innovations deal with improving sales, product design, and launch of a product in another country. Organizational innovations concern, for example, business reengineering, the integration or de-integration of departments, or first use of alliances, partnerships, outsourcing, or sub-contracting. For a better overview of the definitions see Table 2 below.

Table 2: Innovation types covered in CIS

PRODUCT INNOVATION	**PROCESS INNOVATION**
Represents the introduction of new or significantly improved goods or services with respect to their characteristics or intended use. This includes significant improvements in technical specifications, components, and materials, software, user-friendliness, or other functional characteristics. Unlike the innovation process, products are sold directly to customers.	Represents the introduction of new or significantly improved production (production methods) or delivery methods. This includes significant changes in techniques, equipment, and/or software distribution systems. It also includes reduction of the risks of environmental pollution or safety hazards.

MARKETING INNOVATION	ORGANIZATIONAL INNOVATION
Represents an implementation of new marketing methods involving significant changes in product design or packaging, product placement, product promotion, or pricing.	Represents the implementation of new organizational methods in the firm's business practices, workplace organization, or external relations to improve the innovative capacity of the enterprise or its performance characteristics.

The survey covers basic information about the company, the above-mentioned types of innovation, whether the company cooperates with other firms or institutions, economic information about the firm (e.g. turnover and the number of employees in particular years), factors hampering innovation activities, sources of information for product and process innovation, and so on.

2.3 SAMPLE AND SUB-SAMPLES

As in this thesis I focus on studying the innovation activities of firms I rely on firm-level data to test the hypotheses and I use the Community Innovation Survey 2010 (CIS2010) for the Czech Republic and Germany as a dataset throughout the thesis. The data for CIS2010 was gathered in 2011 by means of a voluntary postal survey relating to the period 2008-2010. The target population included all enterprises with ten or more employees and the survey was stratified by size and economic activity. In the Czech Republic the survey was sent to 6229 enterprises representing all manufacturing and service firms. The sample was obtained from the Registry of Economic Units by means of stratified, random sampling in particular industries. In total, 5,151 responses were received. The rate of useful answers was 83%. In the case of Germany the sample comprises 26,850 enterprises (10% of the total number). The written survey took place from March to August 2011. In total, data for 6,851 companies was recorded, which means a return rate around of 26%.

In total, I have 12,002 observations in the full sample (Czech and German CIS combined). I have also created another three sub-samples. In the first empirical chapter I examine in detail various elements of product innovation and organizational innovations. Unfortunately, not all the required information is

present in both the Czech and German datasets and so I split them and used only the Czech one (Sub-sample I), resulting in 5,151 observations. The second empirical chapter deals with factors related to innovation project termination. As a result of the research design, I restrict Sub-sample II to firms that are active in product innovation (having introduced either product or process innovation) as only those firms, which are actively involved in innovation are able to experience the termination of their innovation process. The resulting dataset has 4,385 observations and is suitable for cross-section analyses regarding the dependent and independent variables I employ.

In the third empirical chapter again I use full sample restricted to firms with R&D intensity (ratio of internal R&D expenditures in 2008 to the total turnover of the company in 2008) lower than 0,5 (50 %) and with 10 and more employees so that I avoid biased results. The resulting dataset has 10,721 observations. In the table 3 below I provide a brief overview of the samples used in this study.

Table 3: Overview of sample and sub-samples

	Explanation	**Observations**	**Used Chapter**
Full sample	Czech and German datasets combined without any restriction	12,002	Chapter 2
Sub-sample I	Full sample restricted to companies with technical innovation	4,385	Chapter 4
Sub-sample II	Full sample restricted to Czech companies	5,151	Chapter 3
Sub-sample III	Full sample restricted to companies with absorptive capacity lower than 10	10,721	Chapter 5

As the time-frame (2008-2010) of the survey concurs with the event of financial crisis I have checked for any unusual changes in the financial indicators – turnover in 2008 and 2010.

Table 4: Turnover in 2008 and 2010[3]

Variable	Mean	10th percentile	50th percentile	75th percentile
Turnover 2008 - Czech	887 222	9 748	77 576	381 497
Turnover 2010 – Czech	898 230	9 181	70 819	375 935
Turnover 2008 – German	113 261	351	3 377	17 000
Turnover 2010 - German	103 700	352	3 074	15 896

The results do not provide any indication of significant differences. Moreover 44,7% of the respondents referred positive growth in turnover in 2010 compared to 2008. As this study does not focus on the effects of exogenous shocks such as financial crisis on the results and as I do not possess any data to make inferences in this regard, I would rather opt not to discuss potential relationships between the environmental effects on the results.

2.3.1 Innovation types covered in CIS 2010

Upon closer examination of the full sample, it is possible to determine how many enterprises introduced particular types of innovation. As mentioned above, the CIS questionnaire was designed in four directions, to cover product, process, marketing, and organizational innovations. The figure 2 below shows the percentage of firms that introduced different types of innovation during the years 2008-2010.

The most common type of innovation was organizational innovation, with 4,902 companies (41%) introducing some kind of new organizational method in their business practice. The chart clearly shows that almost 63% of the companies introduced at least one of the types of innovation during the years 2008-2010.

[3] Numbers are in thousands CZK for Czech Republic and in thousands EUR for Germany.

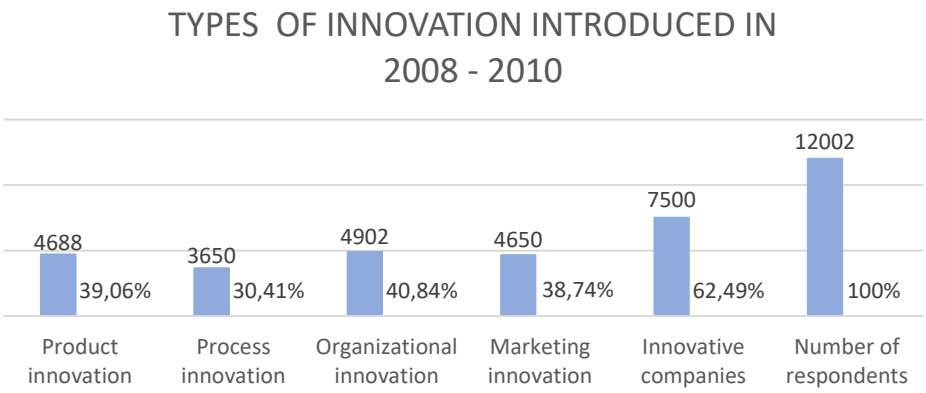


Figure 2: General types of innovation introduced in 2008–2010.

All the types of innovation except process innovation (with ca. 30%) are almost equally distributed among the companies with a rate of approximately 40%.

For a more detailed overview of particular types of innovation see the figure 3 below.

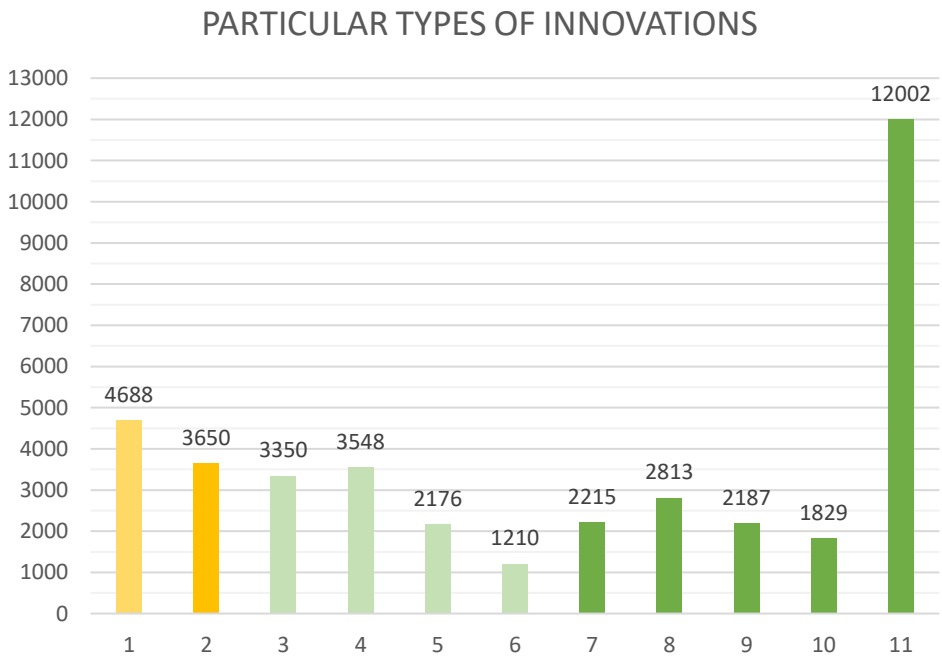


Figure 3: Particular types of innovation introduced in 2008-2010.

Product innovations – in 2008-2010 the enterprise introduced:

1 – New or significantly improved goods

Process innovations – in 2008-2010 the enterprise introduced:

2 – New or significantly improved methods of manufacturing or producing goods or services

Organizational innovations – in 2008-2010 the enterprise introduced:

3 – New business practices for organizing procedures (e.g. supply chain management, knowledge management, lean production, quality management, etc.)

4 – New methods for organizing work responsibilities and decision making (e.g. team work, decentralization, integration or de-integration of departments, etc.)

5 – New methods for organizing external relations with other firms or public institutions (e.g. first use of alliances, partnerships, outsourcing or sub-contracting, etc.)

6 – Companies introduced innovations in all three organizational innovation modes

Marketing innovations – in 2008-2010 the enterprise introduced:

7 – Significant changes in the design or packaging of a good or service.

8 – New media or techniques for product promotion (a new brand image, introduction of loyalty cards, etc.)

9 – New methods for product placement or sales channels (e.g. first-time use of franchising or distribution licences, direct selling, a new concept for product presentation, etc.)

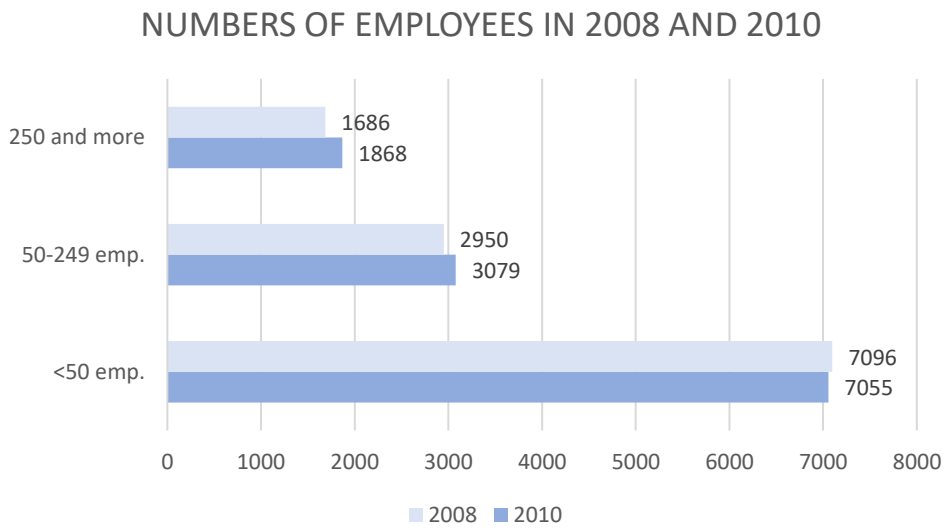
10 – New methods of pricing goods or services (e.g. first-time use of various levels of pricing by demand, discount systems, etc.)

11 – Number of respondents

2.3.2 Classification by number of employees

The companies report the average number of staff members in the years 2008 and 2010. Thus, I can classify the dataset according to the number of employees. I distinguish between three categories of companies: those with less than 50 employees, businesses which have 50-249 employees, and

Figure 4: Numbers of employees in 2008 and 2010.



businesses with 250 and more employees[4].

In 2010 the highest proportion, as could be expected, in both countries was represented by enterprises with less than 50 employees (58%), followed by a group of enterprises with 50-249 employees (25%). The smallest share of respondents belongs to enterprises with 250 and more employees, with a 15% representation.

[4] I do not provide here the official definition of small-medium-large enterprises as defined by the European Commission (Recommendation concerning the definition of micro, small and medium-sized enterprises 2003/361/EC) as employee numbers is not the sole defining criterion. Financial assets are also used to define size categories. Moreover the enterprise has to be non-subsidiary, independent firm. As the exact distinction between firms according to these criterions is not the focus of this thesis, I only use the number of employees ceilings (small firm <50, medium-sized 50-249, and large with 250 and more employees) used by the EC in order to divide the firms into meaningful categories.

2.3.3 Classification by industry

All the respondents had to choose one industry in which the company operates. I use the Eurostat indicators on High-tech industry and Knowledge-intensive services (Eurostat 2016) for industry classification purposes. On a general level I have companies in either the manufacturing or service sector. Then I have a small proportion of companies in the "other" sector as these do not belong to any industry group as described in the Eurostat indicator and identified by its NACE code. On a particular level I distinguish among low-tech industries (food products, beverages and tobacco products, textile manufacturing, wood processing, paper making, and more), medium low-tech, which is engaged in the manufacture of rubber and plastic products, basic metals and metallurgical processing of metals, repair and installation of machinery and equipment, and others. The medium high-tech industries include the production of chemicals, manufacture of arms and ammunition, manufacture of electrical equipment, motor vehicles, medical and dental instruments and supplies, and so on. High-tech industries include aircraft and spacecraft manufacturing, pharmaceuticals, medical, precision and optical instruments, computing machinery, etc. As regards the service sector, I divide it into two categories: knowledge-intensive activities (e.g. scientific research and development, legal and accounting activities, telecommunications, air transport, financial services, education, etc.) and low knowledge-intensive activities (e.g. the wholesale and retail trade, travel agencies, accommodation and food services, warehousing, real estate activities, etc.).

The overall distribution of the industrial sector in both countries is presented in the figure 5 below.

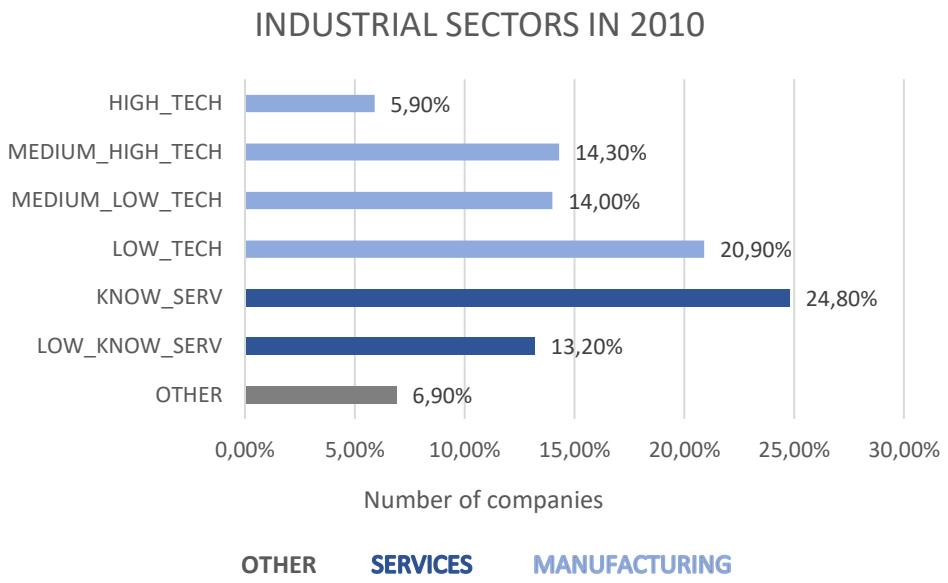


Figure 5: Industrial sectors in 2010.

2.3.4 Abandoned innovation

The companies that were surveyed also answered a question whether, during 2008 to 2010, they had undertaken any innovation activities that did not result in a product or process innovation because the activities were abandoned or still ongoing. One can see that slightly more than one third (34 %) of the companies

were undertaking ongoing innovation activity during 2010. The innovation abandon rate is 13 %.

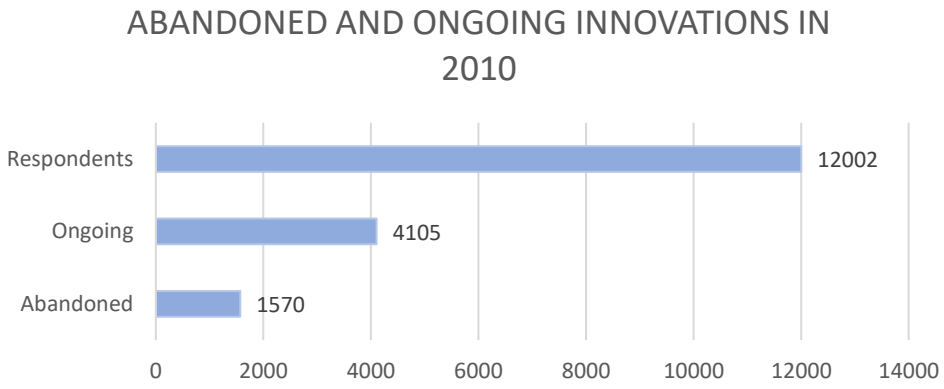


Figure 6: Abandoned and ongoing innovations in 2010.

2.3.5 R&D activities and innovation cooperation

I also include a review of R&D activities in the general description of the dataset. I divided the R&D activities into in-house, external, or both of them. Less than half of the companies had been engaged in any type of R&D activity during 2008-2010 – 47%. Of those which had undertaken any R&D activity, the majority had done so internally (see figure 7).

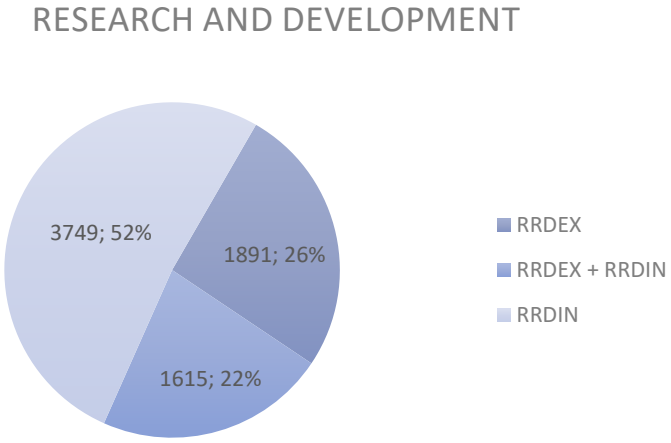


Figure 7: R&D activities.

External R&D activities (RRDEX) – Creative work was done by other companies (other companies, subsidiaries) or public/private research organizations and purchased by the company.

Internal R&D activities (RRDIN) – In-house research and development activities undertaken within the enterprise to increase the stock of knowledge for developing new and improved products and processes.

Internal and external R&D activities (RRDEX + RRDIN) – Using both types at the same time – creative work carried out by other companies and the purchase or licensing of patents and non-patentable inventions, know-how, and other types of knowledge.

2.4 OVERVIEW OF VARIABLES

Here I provide a brief overview of all the dependent, independent, control, and moderating variables used in this study with a basic statistical description.

2.4.1 Dependent variables

a) Innovation performance (TURNIN)

I use innovation performance as the dependent variable in Chapter 5 of this study. More specifically, I measure innovation performance by using a variable indicating the percentage of total turnover in 2010 from new or significantly improved products introduced between 2008 and 2010.

b) Product innovation

I use product innovation as the dependent variable in Chapter 3 of this study. Specifically, I measure product innovation using six different variables. On a general level I distinguish between the market introduction of a new or significantly improved good (INPDGD) or service (INPDSV) with respect to a firm's capabilities, user-friendliness, components, or sub-systems during the three years 2008 to 2010. In order to differentiate between different "quality levels" of product innovation I use four additional dependent variables, i.e. incremental and radical innovation of both goods and services. I have new-to-the-market innovation as an indicator of a radical innovation which has not been introduced by any firm in a particular industry before (NEWMKT_GOODS, NEWMKT_SERV) and, secondly, new-to-the-firm innovation, which reflects rather the ability to imitate and introduce an already-existing technology and/or service to the market (NEWFRM_GOODS, NEWFRM_SERV).

c) Abandoned innovation (INABA)

I use innovation project termination as the dependent variable in Chapter 4 of this study. Specifically, I construct innovation project termination using a binary variable measuring whether the firm had an innovation activity between 2008-2010 that did not result in a product or process innovation because the activity was abandoned or suspended before completion.

2.4.2 Independent variables

a) Organizational innovation

In the CIS 2010 survey I can find three distinctive binary variables for organizational innovation. The first one, ORGBUP, measures the presence or absence of *new business practices for organizing procedures* (e.g. lean manufacturing, quality management, supply chain) during the 2008-2010 period. Then there is ORGWKP, indicating *new methods for organizing work responsibilities and decision making* (e.g. team work, decentralization) during the same time period. And finally, there is the ORGEXR variable for *new methods for organizing external relations with other firms and institutions*. Although this is definitely not an exhaustive list of possible indicators, I can use them as reliable measures of organizational innovation.

In the models I use three independent variables representing organizational innovation. The first one is a construct variable, ORGIN (merging the three above-mentioned variables), measuring changes focused on internal organizational arrangements and changes aimed at relationships with external actors. I use this variable in Chapter 4. In Chapter 3 I use the variables ORGINT (merging ORGBUP and ORGWKP), measuring changes focused on internal organizational arrangements, and ORGEXR, focusing on changes aimed at relationships with the external environment.

b) Open innovation (OI)

To examine whether there is any moderating effect of organizational innovation and absorptive capacity on the relationship between innovation performance
and open innovation practices, I use in Chapter 5 a composite indicator that captures three OI practices:

- *Innovation cooperation*, indicating whether the firm cooperated in any of its innovation activities with other enterprises or institutions during 2008-2010. Innovation cooperation means active participation with other entities or non-commercial institutions on innovation activities. It is not necessary for both partners to benefit commercially. I exclude pure outsourcing activities without active partner involvement;

- *External R&D*, representing purchased creative work and innovative expertise undertaken by external enterprises (including subsidiaries within a group) or by public or private research organizations in order to increase the stock of knowledge for developing new and improved products and processes during 2008-2010;

- *Opening up firm boundaries*, indicating whether a firm introduced new methods for organizing external relations with other firms and institutions (e.g. first use of alliances, partnerships, outsourcing or sub-contracting. etc.) during 2008-2010. It indicates that a firm tried to extend its relationships with its environment and opened up to cooperation with external partners.

The composite or aggregate OI indicator thus ranges from 0 to 3.

c) Research activities

The extent of R&D activities is shown as a very important measure of the innovativeness of individual companies. The RESEARCH variable values range from 0 to 2, depending on whether the firm was engaged in in-house R&D activities and/or external R&D activities (performed by other companies or by public or private research organizations and purchased by the firm) during 2008-2010. I use this variable in Chapter 4.

d) Level of internationalization

The values of the MARKET variable range from 0 to 3, depending on which geographic markets the firm sold goods and/or services in during 2008-2010. Thus, the more markets a firm operates in, the higher the level of internationalization. There are three possibilities: national market; other EU, EFTA, or EU candidate countries; all other countries. I use this variable in Chapter 4.

e) Marketing activities

The values of the MARKETING variable range from 0 to 4, depending on the introduction of a) significant changes to the aesthetic design or packaging of a good or service, and/or b) new media or techniques for product promotion, and/or c) new methods for product placement or sales channels, and/or d) new methods for pricing goods or services during 2008-2010, or 0 otherwise. I use this variable in Chapter 4.

2.4.3 Moderating variables

a) Organizational innovation (ORGIN)

In the models in Chapter 5 I use a construct variable measuring innovations focused on internal organizational arrangements. This variable is the same as the ORGINT variable used as an independent variable in Chapter 4.

b) Absorptive capacity (ABS CAP)

I measure the absorptive capacity of a firm as the intensity of its R&D activities. Many studies demonstrate a clear positive impact of these activities on business performance, measured as the number of new products introduced to the market (Olson et al., 2001) and/or as financial performance (Eberhart et al., 2004; Eberhart et al., 2008). In calculating the variable I follow Spithoven

et al. (2013), who measures it as the ratio of internal R&D expenditures in 2008 to the total turnover of the company in 2008.

2.4.4 Controls

Throughout the study I use a set of common control variables, described below.

a) Size (Ln_SIZE)

Size is one of the typical control variables. Larger companies obviously have more resources; they are innovative and also have more opportunities to invest in product innovation. In the models, I use the natural log of employees in 2008.

b) Industry dummy variables

I also consider it important to check the influence of the industry of individual companies. Here I use the Eurostat indicators on High-tech industry and Knowledge-intensive services (Eurostat, 2016). I have created seven groups of industries: low-technology industries, medium low-technology industries, medium high-technology industries, high-technology industries, low knowledge-intensive services, knowledge-intensive services using low-technology industries and other industries *(LOW_TECH, MEDIUM_LOW_TECH, MEDIUM_HIGH_TECH, HIGH_TECH, LOW_KNOW_SERV, KNOW_SERV, OTHER*).

c) Group membership (GP)

Membership of an international group of companies is also assigned importance as these companies have better access to resources and information directly from the market and also have a better capacity to develop new products. For the purpose of this study, I created a dummy variable. If the company belongs to an international group, the variable has a value of 1, and, if not, 0.

d) Country dummy variable (CZECH)

I control for the geographical association with either Germany or the Czech Republic. I created a dummy variable. If the company is based in the Czech Republic, the variable value is 1 and it is 0 for companies based in Germany.

Table 5: Statistical description of variables

Variable	Type of variable	Used in Chapter	Obs.*	Mean	SD	Min	Max	Cr. A. **
INPDGD	Dependent	3	5.151	0.256	0.436	0	1	
INPDSV	Dependent	3	5.151	0.157	0.364	0	1	
NEWMKT_GOODS	Dependent	3	5.151	0.196	0.397	0	1	
NEWMKT_SERV	Dependent	3	5.151	0.122	0.327	0	1	
NEWFRM_GOODS	Dependent	3	5.151	0.161	0.368	0	1	
NEWFRM_SERV	Dependent	3	5.151	0.0918	0.289	0	1	
INABA	Dependent	4	4.778	0.201	0.401	0	1	
TURNIN	Dependent	5	10.721	6.225	17.082	0	100	
ORGINT	Independent	3	5.151	0.361	0.480	0	1	
ORGEXR	Independent	3	5.151	0.162	0.369	0	1	
ORGIN	Independent	4	4.778	1.239	1.128	0	3	0.75
MARKET	Independent	4	4.778	1.87	1.061	0	3	0.67
RESEARCH	Independent	4	4.778	0.940	0.784	0	2	0.55
MARKETING	Independent	4	4.778	1.237	1.284	0	4	0.65
SIZE	Independent	4	4.778	4.243	1.729	0	12.95	
OI	Independent	5	10.721	0.545	0.876	0	3	0.62
ORG CHANGE	Moderating	5	10.721	0.578	0.799	0	2	0.71
ABS CAP	Moderating	5	10.721	0.020	0.154	0	7.29	
GP	Control	All	11.934	0.325	0.468	0	1	
Ln_SIZE	Control	All	11.661	3.797	1.609	0	12.95	
CZECH	Control	All	12.002	0.429	0.495	0	1	
HIGH_TECH	Control	All	12.002	0.059	0.236	0	1	
MEDIUM_HIGH_TECH	Control	All	12.002	0.143	0.35	0	1	
MEDIUM_LOW_TECH	Control	All	12.002	0.14	0.35	0	1	
LOW_TECH	Control	All	12.002	0.21	0.41	0	1	
KNOW_SERV	Control	All	12.002	0.25	0.43	0	1	
LOW_KNOW_SERV	Control	All	12.002	0.13	0.34	0	1	
OTHER	Control	All	12.002	0.07	0.25	0	1	

* Observations, ** Cronbach's Alpha

As the last column of the table shows, Cronbach's alpha of the construct variables are above the lower limit of 0.6 (Hair et al., 2010)[5] indicating high reliability and consistency for the entire scale. In order to support the reliability of my construct variables and consequently of my results I perform additional analysis – principal component analysis and factor analysis. For all relevant variables (MARKET, RESEARCH, MARKETING and OI) I have got satisfactory results consistently with only one component with eigenvalue higher than 1,0 and with one dominant factor.

2.5 METHODS USED

As regards the methods used to achieve the objectives, I follow several steps in the empirical chapters. First, I perform a simple statistical description of my sub-sample and variables. I show the mean score, the standard deviation, the minimum and maximum scores, and the number of observations of particular variables. As indicated above when needed, I also assess all the construct measures for convergent validity by performing a confirmatory factor analysis and principal component analysis. All the constructs met the suggested minimum value for composite reliability (Hair et al., 2010). I also include the Cronbach's alpha for the independent variables, as in some cases these are constructs. After that I do a pairwise correlation to exclude any potential collinearity issues.

In order to test the hypotheses I use logistic regressions in Chapters 3 and 4 as the dependent variables are binary. In chapter 5 I use tobit regression as the dependent variable - innovation performance - measured by the percentage of total turnover in 2010 from new or significantly improved products introduced between 2008-2010 is a continuous variable that takes an average value of 6.22 percent, and ranges between 0 and 100. The variable is truncated at a value of 0 and large number of its values is clustered at 0. To account for the truncation, Tobit regression is used as it also estimates the regression line at the limit not only above it as other alternatives (McDonald and Moffit, 1980). I run several models in a hierarchical manner, starting with only control variables and gradually adding more independent variables till I reach the full model. So as to ensure

[5] According to Hair, et al. (2010) a reliability estimate of higher than 0.7 suggest good reliability. A reliability between 0.6 and 0.7 is accepted if other validity indicators are good.

internal consistency of my independent variable constructs in chapter 5, I created new variables based on rotated factor loads.

To check for multicollinearity, I conducted a post-estimation variance-inflation factor test. If I look for moderating effects between the variables I calculated the interaction terms using odds ratios (using the standard formula (EXP(coeff)-1)*100) and comparing their values.

3 AN ANALYSIS OF THE INFLUENCE OF ORGANIZATIONAL INNOVATION ON THE PRODUCT INNOVATION OF COMPANIES

3.1 INTRODUCTION

The shortening of products' life cycles, global competition, and quick changes in customer preferences are creating a need to increase innovation performance continuously. The vital role of technological innovations as one of the main preconditions for the long-term survival of any company has been the focus of much research throughout recent decades (Eisenhardt & Tabrizi, 1995; Fontana & Nesta, 2009; Strebel, 1987). At the same time organizational innovation has been recognized as being just as important as technological innovation in a firm's competitiveness and effectiveness (Damanpour & Evan, 1984). As Lam states, organizational innovation is a "*necessary precondition for technological innovation*" (Lam, 2005, p. 115).

Although there is a vast body of literature showing what set of organizational factors is the most suitable one for enabling product innovation (Ernst, 2002), or what the causes of product failure are (Cooper, 1975; Leoncini, 2016), there is less evidence on the relationship between organizational and product innovations per se. But product innovation can take place only if the organization has the capability to do so, i.e. if there exists enabling organizational arrangement and a sound innovation management is applied. Inappropriate organizational design may result in malfunctions as the majority of failures in innovation are due to weaknesses in management of the innovation process (Tidd et al., 2005). The critical challenge in product innovation is how to establish and manage the formal and informal organizational structures (Sosa & Mihm, 2008) within as well as outside the firm.

The importance of organizational innovation for competitiveness has been a focus of several studies (Caroli & Van Reenen, 2001; Damanpour, et al., 1989; Greenan, 2003; Piva & Vivarelli, 2002). These studies supported the view that organizational innovation act as the pre-requisites and facilitators of product innovation, depending on the degree to which the organizational structures respond to the use of new technologies. Moreover, other studies (e.g. Womack,

et al., 1990; Hammer & Champy, 1993; Goldman et al., 1995) showed that organizational innovations present a competitive advantage since they themselves have a significant impact on business performance with regard to productivity, lead times, quality and flexibility.

The present study expands current knowledge on the effect of organizational innovation on product innovation especially by differentiating among the types of product innovation (incremental vs. radical) and industries (services vs. manufacturing). Another contribution of this chapter is that I combine open innovation with organizational innovations as explanatory factors in explaining innovation performance. Open innovation has not been connected so far with organizational innovations. Therefore, the research question of this chapter is: "*Are organizational innovations of a firm (particularly introduction of new internal procedures) and open innovation activity (measured by methods of organising external relations) associated with innovativeness of a firm (measured by product innovation)"?*

Unfortunately, there is no consensus on the meaning of the term *organizational innovation* as the concept has not been defined unambiguously yet. Birkinshaw et al. (2008) and Hamel (2006) use the term management innovation, Damanpour (1991) writes about administrative innovation, and Armbruster et al. (2008) refer to non-/technical process innovation.

Organizational innovations comprise changes in the structure and processes of an organization due to implementing new managerial and working concepts and practices, such as the implementation of teamwork in production, supply chain management or quality management systems (OECD, 2005; Damanpour 1987; Damanpour & Evan, 1984). The characteristic feature distinguishing organizational innovation from other types of organizational changes is the implementation of an organizational method which has not been used in the firm before and which is an outcome of a strategic choice made by the management.

Here I take the point of view of strategic adaptation and continuous change, which perceives firms as proactive actors in the process of organizational change rather than passive objects of the environmental selection process. It means that firms are able to constantly evolve as a result of proactively searching for and utilizing new knowledge and innovative activities in order to recombine their core

competencies and/or making changes in their product market domain (Floyd & Lane, 2000). Product innovation, then, is a vehicle for the adaptation process as to put it into practice firms must fundamentally change how they organize themselves (Dougherty & Hardy, 1996).

To examine the relationship between organizational innovation, open innovation and product innovation empirically I analysed firm-level data from the cross-sectional Community Innovation Survey 2008-2010 for the Czech Republic (CIS 2010). The data for CIS 2010 was gathered in 2011 by means of a questionnaire sent to all enterprises with ten or more employees, stratified by size and economic activity. The survey covered manufacturing as well as service firms. In total 5,151 responses were received.

The results show that for successful product innovation both organizational innovations in internal procedures, as well as the need to reach out to external partners, are important in the manufacturing and service industries. Moreover, these changes are positively associated with both incremental and radical product innovations.

The remainder of the chapter is structured as follows. The next section is a review of the literature concerning various aspects of the relationship between organizational and technological innovations. I then formulate the research hypotheses. In Section 3.5, I will discuss the research design and the regression results. In the last section I highlight the theoretical and managerial implications of the findings, discuss the study's main limitations, and make suggestions for the course of future research.

3.2 LITERATURE REVIEW

"Innovate or die" resonates as a new mantra within various branches of management literature. But bringing new products onto the market on a continuous basis never comes easy. There are many factors influencing the probability of a new product becoming a success story. First of all, high-quality preparatory work (including commercial assessment and customer integration) on the project is crucial (Cooper & Kleinschmidt, 1993). Second, the organization itself needs to be "innovation-friendly" and nurture an "entrepreneurial climate" (Cooper & Kleinschmidt, 1995), fostering interfunctional communication and

cooperation (Balbontin et al., 1999; Maidique & Zirger, 1984) and experimenting with new forms of organizational processes creating decentralized and more fluid structures that nurture knowledge flow, diversity, and autonomy (Reeves & Deimler, 2011). For a thorough overview of the success factors of new product development see Ernst (2002).

But the problem with the inability to innovate is strongly connected with the functioning of organizations themselves. As Leonard-Barton (1992) shows, the core capabilities of a firm that were once responsible for successful products (e.g. employee knowledge and skills, technical and managerial systems, and values and norms) could easily develop into core rigidities that inhibit any progress. These strong and enduring inertial forces exerted by ossified competencies are difficult to overcome. The organization's structures, procedures, and relationships continue to reinforce prior patterns of behaviour and to resist new ones. Dougherty and Hardy (1996, p. 1132) showed in their qualitative research of 15 large and mature US companies that "product innovations occurred in spite of the organizations, not because of them". Thus there is a need for new capabilities and organizational arrangements within companies so as to be able to fully exploit the potential of, and manage, technological innovation activities. In other words, there is a need for "continuous strategic renewal, (which) is the only insurance against irrelevance" (Hamel, 2006, p. 78).

There are several theoretical perspectives used by scholars studying strategic renewal. Important contributions were based on an evolutionary approach which perceives strategic renewal as a capability to anticipate and ward off external selection processes (Burgelman, 1991). Chakrawarthy (1984), on the other hand, influenced by a strategic choice perspective, emphasized the active role of top management in setting the strategic renewal path. Others have sought an explanation of change from a cognitive perspective (Barr et al., 1992), middle-management involvement (Floyd & Wooldridge, 1997; Floyd & Wooldridge, 2000), and co-evolutionary perspectives (Volberda et al., 2001). More recently, the dynamic capabilities view has been applied widely (Agarwal & Helfat, 2009; Augier & Teece, 2009; Capron & Mitchell, 2009; Salvato, 2009) with a sub-group of works focusing on dynamic managerial capabilities (Helfat & Martin, 2014; Kor & Mesko, 2013).

On the basis of the above-mentioned theoretical perspectives, I argue that the ability to renew itself means that an organization is able to constantly evolve as a result of proactively searching for and utilizing new knowledge and innovative activities in order to recombine its core competencies and/or make changes in its product market domain (Floyd & Lane, 2000). The renewal process is the manifestation of adaptation to a changing environment, meaning the organization is able to read and act on signals of change quickly (Reeves & Daimler, 2011), long before it has to, or before it is too late and costly (Hamel, 2006).

In the literature I find two distinctive streams dealing with (i) "discontinuous strategic transformations" and (ii) "incremental renewal" (Agarwal & Helfat, 2009, p. 283). This distinction stems from the organizational change literature, which distinguishes between incremental versus radical change (e.g. Tushman & Romanelli, 1985), Meyer et al. (1993) introduce different terminology: first-order (continuous) versus second-order (discontinuous) change, Abernathy & Clark (1985) use competence-enhancing versus competence-destroying change. Discontinuous transformations represent major, fundamental shifts in the firm's productive core that instil an entirely new set of organizational behaviours (Choi, 1995) and demand major implementing operations (Volberda et al., 2001). Incremental renewal, on the other hand, refers to a stream of continuous innovations and changes to attributes necessary to support these innovations which can be executed with much less demanding operations. Hence, it entails continual adaptation (Kearney & Morris, 2015).

Taking into account resources and capabilities, radical changes entail considerable re-combination and transformation of resources when compared to their incremental counterparts (Dewar & Dutton, 1986). In fact, in view of their non-routine nature, they always imply fundamental changes along multiple dimensions such as building the technologies, business models, and organizational structures needed to cope with the change (Agarwal & Helfat, 2009). Thus radical changes are seen as rare, risky, and episodic (Brown & Eisenhardt, 1995). Because of the difficulties stemming from major transformations, companies may instead focus on small-scale yet continuous changes that enable them to respond effectively to a changing environment. Thus incremental strategic renewal, when undertaken proactively, reduces the need for a much larger and more difficult

transformation later on (Agarwal & Helfat, 2009). I find many examples of renewal efforts in the literature, including changes to the organizational identity, described by Tripsas in a digital photography company (2009), renewal through corporate venturing activities (Gutiérrez et al., 2017), conducting research and development on a regular basis (Murray & O'Mahony, 2007), and new product development (Dougherty, 1992; Daneels, 2002).

3.3 HYPOTHESES

3.3.1 Organizing for innovation

There exists a wide array of literature on organizing for innovation, focusing mainly on searching for product success factors (e.g. Rothwell et al., 1974; Cooper, 1979; Cooper & Kleinschmidt, 1987; Maidique & Zirger, 1984; Zirger & Maidique, 1990). In particular, Brown and Eisenhardt (1995) defined several organizational factors as being critical to new product developing success, i.e. pre-development planning followed by preliminary market and technical assessment, cross-functional skills etc. Innovation projects are also more likely to be successful when they have been supported by top management (Rothwell, 1972). Others were looking for the best fit between the firm's resources, capabilities, organizational arrangement, and product development needs. In that sense Dougherty (1992) stated "*if an appreciation for how a product fits with the firm is not developed, then the product innovation does not become part of the firm during its development*" (p. 84). Still other studies focus on the design of organizational structures for product innovation. Sosa and Mihm (2008) show for instance that the product innovation process is mainly about striking a balance between formal structures ensuring efficient design and planning and informal structures enabling communication networks of people involved in the development process. There are multiple approaches dealing with that process of balancing, such as the project-based organization, functional organization, modular organization design, social networks, etc., each emphasizing different aspects of the problem.

All of the above-mentioned research approaches have something in common – if companies pursue sustained product innovation they must fundamentally change the way they are organized (Dougherty & Hardy, 1996). A major challenge

to connect innovations with routine operations then arises as "*new products are inextricably bound up with the rest of the organization*" (p. 1122). It is mainly up to the management to enable innovation-to-organization connections, especially through resource allocation, collaborative structures, and processes to solve problems, and through incorporating innovation into the organization's strategy. "*Each innovation project also needs administrative structures and processes appropriate to its development stage and access to decision making across the organization*" (p. 1123). There are many possible mechanisms that can be used to create these connections, such as cross-functional teams, committees and task forces, modular structures, task interdependence, etc. Again, the common denominator here is that the practice of product innovation requires the introduction of new organizing principles such as a redefinition of work responsibilities, an emphasis on collaboration, and ongoing strategy revision (Dougherty, 1992). Moreover, Teece (2010) argues that, to profit from technological innovations, enterprises must adopt new organizational forms, methods and business models that are of equal importance.

Based on the arguments mentioned above I hypothesize:

H1: The introduction of organizational innovation aimed at internal practices and procedures is positively associated with the introduction of both new and significantly improved goods and services.

3.3.2 External cooperation/open innovation

It is widely acknowledged that internal knowledge resources are not enough for continuous product innovation and if a company wants to stay ahead of the innovation peloton it should enrich its knowledge portfolio by external knowledge sources, e.g. universities and R&D labs, competitors, customers, and other users outside the firm who are an important source of valuable innovations (von Hippel, 2005). Ahuja (2000) found in his longitudinal study in the chemical industry that both direct and indirect ties with external actors have a positive impact on innovation output as measured by new patents. Other positive effects of collaboration include knowledge sharing (Caloghirou et al., 2004), skills and capabilities complementarity (Arora & Gambardella, 1990), and taking advantage of economies of scale (Ahuja, 2000). In order to tap into the vast ocean of external knowledge the firm has to engage in external communication, which

is critical to successful product development (Brown & Eisenhardt, 1995). Specifically, the role of "gatekeepers" who are able to reach out to sources of technical information outside their organization has been observed (Allen, 1971; Katz & Tushman, 1981). The positive contribution of gatekeepers to product innovation lies mainly in their ability not only to gather useful information from the outside but also to disperse it in a meaningful way among other team members. In their study of 45 new product teams in hi-tech companies Ancona and Caldwell (1990) introduced "scouting" as one of the boundary activities that involve scanning for ideas and information about the competition, the market, or the technology. Another important theme related to external communication focuses on targeting customers to gather as much information as possible in order to understand their needs (Griffin & Hauser, 1993). And last but not least, because of the proliferation of IT I can observe a new trend of user collaboration as many firms are reaching out to user communities in order to help them design, develop, and distribute new products. As with other factors, over-search could have a detrimental effect on performance, as confirmed by Laursen and Salter (2006), who posited that the breadth of external searches exhibits a curvilinear relationship with performance.

Nonetheless, managerial practice shows that we can distinguish between different strategies that can be employed to acquire and internalize technological knowledge in addition to OI: the firm's innovation strategy. A firm can rely on a combination of different strategies to engage in innovation. Damanpour and Aravind (2011) argue that the adoption of a single type of innovation or even a set of innovations of „only one type" may not enable firms to fully realize the positive effects of innovation on performance. The search for external knowledge needs to be accompanied by effective transfer and diffusion within the organizational boundaries. To do this, firms need to develop complementary internal networks (Hansen & Nohria, 2004) and structures that integrate the external knowledge into the firm's innovation process (Chiaroni et al., 2010, 2011). As with other processes, search activities needs to be planned, coordinated, and assessed. Then the right set of procedures and sub-processes has to be put in place.

H2: The introduction of new methods for organizing external relations is positively associated with the introduction of new or significantly improved goods or services.

H3: The positive effect of new methods for organizing external relations on the introduction of new or significantly improved goods and services is amplified when organizational innovations aimed at internal practices and procedures are introduced as well.

There is a need for highly adaptable organization but to achieve that one needs to challenge the set of management principles such as standardization, planning and control, and hierarchy and rather try to enhance devolution, activism, allocation flexibility, or competition (Hamel, 2006). This comprehensive change of management practices, processes, and structure intended to facilitate product innovation can deliver a potent advantage to the innovating company (Hamel, 2006). As Reeves and Daimler pointed out, sustainable competitive advantage "*stems from the "second-order" organizational capabilities that foster rapid adaptation*" (2011, p. 137). Organizational innovations[6] can therefore serve as an adaptive, direction-setting basis for actions taking place within the company, including actions directed at developing new products. For instance, a strategic decision to develop a new good or service, either radical or incremental, that is more in line with current or future customer requirements can trigger wider changes in organizational arrangements and structures (such as the redesign of business units, new methods for resource allocation and motivation, external searching, etc.). Additionally, changing the business concept is likely to result in developing new products and/or processes that fit that concept. The reverse is far less likely since new products, developed as a linear interpretation of the current business model, will rarely trigger the firm to abandon or put at risk the business model on which its (often successful) products are based (Hamel, 2000). To change the current product path dependency the firm has to reinvent the processes that govern management work (Hamel, 2006). That is why Bowen

[6] I use the term organizational innovation interchangeably with management innovation (Birkinshaw et al., 2008), administrative innovation (Damanpour & Evan, 1985) and non-technical innovation (Camisón & Villar-López, 2011) meaning on the general level changes in the management practices, processes, and structures within a firm.

et al. (1994) labelled development projects as "agents of change" (p. 111). Product innovation efforts need to be accompanied by organization-wide changes; otherwise they are more prone to failure (Dougherty & Cohen, 1995). This was also confirmed by Damanpour and Evan (1984), who showed that the adoption of administrative innovation facilitates the adoption of technical innovation.

The degree of "newness" or "novelty" is an important dimension in defining a product innovation. Previous research maintains that the adoption of radical innovation requires new organizational procedures, routines, capabilities, management practices, i.e. organizational innovation (Chandy et al., 2003; MacMillan et al., 1985; McDermott & O'Connor, 2002). Furthermore Sainio et al. (2012) and Teece (2010) argue that radical technological innovation demands new business models to support the exploitation and application of those innovations. In the light of the above-mentioned arguments I hypothesize that:

H4a: The introduction of organizational innovation aimed at internal practices and procedures is positively associated with both new-to-the-market and new-to-the-firm goods and services.

H4b: The introduction of new methods for organizing external relations is positively associated with the introduction of both new-to-the-market and new-to-the-firm goods and services.

H5: The positive effect of new methods for organizing external relations on the introduction of both new-to-the-market and new-to-the-firm goods and services is stronger when organizational innovations aimed at internal practices and procedures are introduced as well.

3.4 METHOD

3.4.1 Data and sample

The data used in this analysis stems from the Community Innovation Survey 2010 for the Czech Republic. The CIS uses a harmonized questionnaire for all EU member states. Because of its long-standing experience the CIS represents a unique and reliable source of data regarding the innovation activities of enterprises of different sizes and ages and in different industries across the EU. The CIS methodology is based on a revised version of the Oslo Manual 2005 which distinguishes four types of innovation: product, process, marketing, and

organizational innovations. Product and process innovations are related to what are termed technical or technological innovations. Marketing and organizational innovations are recognized as new forms of innovation and belong to the non-technical innovations group.

The data for CIS2010 were gathered in 2011 by means of a voluntary postal survey relating to the period 2008-2010. The target population included all enterprises with ten or more employees and the survey was stratified by size and economic activity. The survey was sent to 6229 enterprises, representing all Czech manufacturing and service firms. The sample was obtained from the Registry of Economic Units by means of stratified random sampling in particular industries. In total, 5,151 responses were received. The rate of useful answers was 83% and a non-response analysis revealed no systematic non-response bias.

Since it is the explicit aim of this thesis to gain a firm-level insight into the way innovations are conceived and commercialized, the CIS is a unique instrument. In 2010, it was already the sixth time the survey had been conducted: in this way, the CIS survey has the advantage that it covers organizational innovation. At the same time it has gained external validity because the same questionnaire has been used in most European countries. It focuses on the efforts and experiences of firms and is devoid of country-specific influences.

The broad sample of the CIS can be used to confront the qualitative findings from the case studies with the quantitative elements in the CIS. Here a multitude of indicators can be looked at to search for the most parsimonious model that fits the data. These indicators include the hampering factors, innovation activities, external sourcing, research collaboration, and, least analyzed, the organizational innovations.

The cross-sectional character of the CIS also brings about constraints, which were highlighted by Armbuster et al. (2008). The three-year time lag used in the CIS can lead to incorrect results. Organizational innovations have a different life-cycle, as product innovation and enterprises might benefit from them for more than three years; therefore, the firms that might have introduced organizational innovations more than three years ago (before the CIS survey) are considered here to be non-innovators. But, as pointed out by Evangelista and Vezzani (2010),

a three-year time-span provides sufficient time to cover the internal and external changes and their impact on the other activities of a firm.

The second constraint of using the CIS data regards the causal relationships between different types of activities. Camisón and Villar-López (2014) pointed out that as a result of the cross-sectional nature of the data I cannot test for causal links between the constructs. However, the data is suitable for exploring structural associations between the above-mentioned types of innovation.

3.4.2 Dependent variables

a) Product innovation

I use product innovation as the dependent variable in this chapter. Specifically, I measure product innovation using six different binary variables. I distinguish between the market introduction of a new or significantly improved good or service with respect to a firm's capabilities during the three years 2008 to 2010 (INPDGD and INPDSV). In order to differentiate between different "quality levels" of product innovation I use four additional dependent variables, i.e. incremental and radical innovation of both goods and services (NEWFRM_GOODS, NEWFRM_SERV, NEWMKT_GOODS, NEWMKT_SERV. I have new-to-the-market innovation as an indicator of a radical innovation, that is an innovation which has not been introduced by any firm in the particular industry before and secondly, new-to-the-firm innovation, which reflects the ability to replicate and introduce an already-existing technology and/or service in the market.

3.4.3 Independent variables

a) Organizational innovation

In the CIS 2010 survey I can find three distinctive binary variables for organizational innovation. The first one, ORGBUP, measures the presence or absence of new business practices for organizing procedures (e.g. lean manufacturing, quality management, supply chain) during the 2008-2010 period. Then there is ORGWKP, indicating new methods for organizing work responsibilities and decision making (e.g. teamwork, decentralization) during the same time period, and finally the ORGEXR variable for new methods of organizing external relations with other firms and institutions. Although this is definitely not

an exhaustive list of possible indicators, I can use them as measures of organizational innovation.

In the models I use two independent variables representing organizational innovation. The first one is the construct variable ORGINT (merging ORGBUP and ORGWKP), measuring changes focused on internal organizational arrangements, whereas the second is ORGEXR, focusing on changes aimed at relationships with the external environment.

3.4.4 Controls

a) Size

Size is one of the typical control variables. Larger companies obviously have more resources; they are innovative and also have more opportunities to invest in product innovation. In the models, I use the natural log of employees in 2008.

b) Age

Some researchers have referred to the fact that younger companies tend to be more innovative than older ones when it comes to the degree of innovation (radical vs. incremental) (Koberg et al., 2003). However, others have shown in their studies that the age is positively associated with new product introduction (Nystrom et al., 2002). I obtained the natural log age of a firm by deducting the year of its foundation from the year in which the survey was conducted.

c) Industry dummy variables

I also consider it important to check the influence of the industry individual companies are in. Here I used the Eurostat indicators on Hi-tech industry and Knowledge-intensive services (Eurostat, 2016). I have created six groups of industries: low-technology industries, medium low-technology industries, medium high-technology industries, high-technology industries, low knowledge-intensive services, and knowledge-intensive services, using low-technology industries as a default category.

d) Group membership

Membership in the international group of companies is also assigned importance and these companies have better access to resources, information directly from the market, and also a better capacity to develop new products.

In this case, I created a dummy variable. If the company belongs to an international group, the variable value is 1 and if not it is 0.

e) R&D intensity

The extent, or, better to say, the intensity of R&D activities has been shown to be a very important measure of innovativeness of individual companies. Many studies have demonstrated a clear positive impact of these activities on business performance, measured as the number of new products introduced to the market (Olson et al., 2001) and/or as financial performance (Eberhart et al., 2004; Eberhart et al., 2008). In calculating the variable I followed Spithoven et al. (2013) and used the ratio of internal R&D expenditures in 2008 to the total turnover of the company in 2008.

3.5 RESULTS

3.5.1 Descriptive statistics

Table 6: Descriptive statistics

Variables	(1) Obs.	(1) mean	(2) sd	(3) min	(4) max
Dependent variables					
INPDGD	5151	0.256	0.436	0	1
INPDSV	5151	0.157	0.364	0	1
NEWFRM_GOODS	5151	0.196	0.397	0	1
NEWFRM_SERV	5151	0.122	0.327	0	1
NEWMKT_GOODS	5151	0.161	0.368	0	1
NEWMKT_SERV	5151	0.0918	0.289	0	1
Independent variables					
ORGINT	5151	0.361	0.480	0	1
ORGEXR	5151	0.162	0.369	0	1
Control variables					
Ln_SIZE	5151	4.071	1.444	0	10.50
Ln_AGE	5151	2.528	0.558	0	4.094
GP	5151	0.365	0.481	0	1
RD_INTENSITY	5151	0.0102	0.0634	0	1.616
HIGH_TECH	5151	0.0359	0.186	0	1
MEDIUM_HIGH_TECH	5151	0.163	0.369	0	1
MEDIUM_LOW_TECH	5151	0.164	0.370	0	1
LOW_KNOW_SERV	5151	0.126	0.332	0	1
KNOW_SERV	5151	0.176	0.381	0	1
OTHER	5151	0.0905	0.287	0	1
LOW_TECH	5151	0.244	0.430	0	1

Table 5 shows the mean score, the standard deviation, the minimum and maximum score, and the number of observations of particular variables. I also calculated the Cronbach alpha for "internal organizational innovation", which is a construct variable with a satisfactory score of 0.78. Almost 26% of the enterprises had introduced new or significantly improved goods (INPDGD) and 16% had introduced new or significantly improved services (INPDSV). Respondents producing goods reported that 20% of the product innovations were new to the firm, which implies they were incremental innovations. This is 12% for services. For goods, 16% of the respondents had introduced new-to-the-market innovations (i.e. radical product innovations). In services this is 9%. Internal organizational innovations were reported by 36% of the firms and changes in the external relations in 16% of the cases. The firms were also asked about the importance of the objectives of the organizational innovations. The most important goal for them was to improve the quality of their products, followed by the ability to develop a new product, to reduce the time taken to respond to a customer's
or supplier's needs, and to reduce costs per unit output, and the least important objective was improving communication or information sharing within the firm or with external partners. As regards the control variables, I observe a relatively large number of companies that are part of an international group (36%), which is a direct consequence of the high degree of openness of the Czech economy. Furthermore, the results indicate that about 66% of the companies belong to the manufacturing sector. Most of them are part of what are termed low-technology industries (25%) and only 3% of the respondents reported being active in hi-tech sectors (3%). Another 34% of the respondents are active in the service sector. I refer the reader to Table 6 for the correlations between the variables I use in this study.

Table 7: Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
INPDGD (1)	-																	
INPDSV (2)	0.340	-																
NEWFRM_GOODS (3)	0.841	0.317	-															
NEWFRM_SERV (4)	0.317	0.863	0.405	-														
NEWMKT_GOODS (5)	0.748	0.286	0.477	0.218	-													
NEWMKT_SERV (6)	0.317	0.738	0.243	0.485	0.458	-												
ORGINT (7)	0.328	0.326	0.284	0.291	0.273	0.244	-											
ORGEXR (8)	0.270	0.307	0.257	0.270	0.226	0.248	0.515	-										
Ln_SIZE (9)	0.281	0.111	0.253	0.096	0.226	0.109	0.273	0.236	-									
Ln_AGE (10)	0.025	0.013	0.022	0.007	0.027	0.010	0.007	0.008	-0.008	-								
GP (11)	0.192	0.128	0.170	0.108	0.152	0.109	0.237	0.221	0.481	-0.016	-							
RD_INTENSITY (12)	0.138	0.167	0.130	0.131	0.123	0.161	0.088	0.063	-0.039	-0.009	0.031	-						
HIGH_TECH (13)	0.133	0.032	0.101	0.030	0.125	0.062	0.029	0.025	0.038	-0.004	0.040	0.056	-					
MEDIUM_HIGH_TECH (14)	0.196	-0.036	0.162	-0.028	0.141	-0.006	0.061	0.064	0.197	0.019	0.138	0.001	-0.085	-				
MEDIUM_LOW_TECH (15)	0.059	-0.053	0.043	-0.048	0.055	-0.030	0.031	-0.005	0.100	0.006	0.030	-0.017	-0.086	-0.196	-			
LOW_KNOW_SERV (16)	-0.161	-0.030	-0.142	-0.022	-0.122	-0.060	-0.017	-0.039	-0.027	-0.038	-0.022	-0.054	-0.073	-0.168	-0.168	-		
KNOW_SERV (17)	-0.073	0.245	-0.055	0.194	-0.056	0.183	0.060	0.103	-0.160	-0.019	0.075	0.146	-0.089	-0.204	-0.205	-0.176	-	
OTHER (18)	-0.142	-0.032	-0.120	-0.030	-0.118	-0.049	-0.047	-0.036	-0.016	-0.027	-0.016	-0.047	-0.061	-0.139	-0.140	-0.120	-0.146	-
LOW_TECH (19)	0.007	-0.111	0.014	-0.084	0.000	-0.079	-0.101	-0.099	-0.098	0.044	-0.201	-0.066	-0.110	-0.251	-0.251	-0.216	-0.263	-0.179

3.5.2 Logit regression models – organizational innovation

In order to test the hypotheses, I ran several logit regression models in which I examined the relationships between the introduction of new or significantly improved goods and services and the organizational innovations aimed at internal procedures and external relationships. Table 7 shows the results of modelling the impact of organizational innovations on the introduction of either new goods or services onto the market. I used the logit regression in a hierarchical manner, starting with the control variables only and adding ORGINT and ORGEXR as explanatory variables. Moreover, I also estimated the interaction terms to infer how the effect of internal organizational innovations on product innovation depends on the magnitude of changes in methods organizing external relations. I further examined the individual models by means of a postestimation log-likelihood test to determine whether the models are significantly different. In the end, I performed a VIF postestimation test with a mean result of 2.83 and slightly higher results of 8.05 for age and 9.61 for size, but still below the threshold of 10.00.

The results in Table 7, particularly models 2 and 3 for new goods and models 7 and 8 for new services, confirm both hypotheses 1 and 2 regarding the impact of organizational innovations on the ability to bring new products onto the market. As the results indicate, for successful product innovation both organizational innovations in the internal procedures and the need to reach out to external partners are important to explain product innovation in the manufacturing and service industries. At the same time hypothesis 3 has also been confirmed by the results described in Table 7, models 5 and 10. There is a negative and statistically significant effect of the interaction term of both types of change on product innovation seems to contradict hypothesis 3.

Based on the results in model 5, I can conclude that companies that introduced either new business practices for organizing procedures or new methods of organizing work responsibilities and decision making during the period 2008-2010 (ORGINT) have a 241%[7] greater chance of having introduced a new product onto the market during the same period. Similarly, companies that established

[7] I calculated the interaction terms using odds ratios (using the standard formula (EXP(coeff)-1)*100)

external relations with other firms or public organizations through alliances, partnerships, outsourcing, or subcontracting in the period 2008-2010 (ORGEXT) were three times (299%) more likely to introduce a new product onto the market in that same period. Companies can combine the introduction of organizational innovations and the establishment of new relations with partners: combining the effect of the two main terms and the interaction term leads to a staggering probability almost five times (483%) higher of introducing a new product onto the market. In other words, even though the interaction term is negative, the dampening effect is relatively small and does not outweigh the benefits of combining organizational innovations with the expansion of a firm's network of partners.

There are some interesting results regarding the control variables: firm size and the intensity of the R&D activities of the company are statistically significant in all the models. Group membership is a strong predictor of the introduction of new goods, whereas it has no significance in the case of new services. The opposite applies for the age of the company as it seems that the older companies in the service sector are more innovative. On the other hand, the age is not a significant predictor of innovativeness in manufacturing.

Table 8: Logistic regressions on product innovation

	New goods					New services				
VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7	(8) Model 8	(9) Model 9	(10) Model 10
ORGINT		1.393***		1.163***	1.227***		1.728***		1.420***	1.493***
		(0.0768)		(0.0854)	(0.0886)		(0.0930)		(0.104)	(0.108)
ORGEXR			1.291***	0.650***	1.384***			1.509***	0.772***	1.538***
			(0.0927)	(0.103)	(0.288)			(0.0946)	(0.106)	(0.317)
ORGINT#c.ORGEXR					-0.833***					-0.841**
					(0.307)					(0.334)
GP	0.361***	0.232***	0.275***	0.206**	0.198**	0.230**	0.0553	0.0905	0.0112	0.00285
	(0.0839)	(0.0877)	(0.0863)	(0.0885)	(0.0885)	(0.0934)	(0.0983)	(0.0977)	(0.0998)	(0.0999)
Ln_SIZE	0.370***	0.284***	0.307***	0.267***	0.268***	0.288***	0.167***	0.196***	0.141***	0.142***
	(0.0285)	(0.0298)	(0.0293)	(0.0300)	(0.0300)	(0.0323)	(0.0337)	(0.0337)	(0.0343)	(0.0343)
Ln_AGE	0.0841	0.0738	0.0772	0.0701	0.0702	0.146*	0.139*	0.141*	0.136*	0.135*
	(0.0641)	(0.0668)	(0.0661)	(0.0674)	(0.0674)	(0.0756)	(0.0789)	(0.0785)	(0.0800)	(0.0798)
RD_INTENSITY	6.263***	5.309***	5.885***	5.311***	5.283***	4.778***	3.960***	4.448***	3.963***	3.954***
	(0.803)	(0.741)	(0.788)	(0.747)	(0.749)	(0.713)	(0.665)	(0.686)	(0.665)	(0.669)
HIGH_TECH	0.947***	0.942***	0.917***	0.927***	0.922***	0.746***	0.683***	0.667***	0.652***	0.644***
	(0.172)	(0.180)	(0.175)	(0.180)	(0.181)	(0.214)	(0.224)	(0.222)	(0.226)	(0.226)
MEDIUM_HIGH_TECH	0.391***	0.374***	0.359***	0.359***	0.358***	0.0503	-0.0370	-0.0557	-0.0810	-0.0803
	(0.102)	(0.107)	(0.105)	(0.108)	(0.108)	(0.151)	(0.156)	(0.156)	(0.158)	(0.158)
MEDIUM_LOW_TECH	-0.0559	-0.139	-0.0797	-0.138	-0.142	0.0569	-0.0280	0.0216	-0.0317	-0.0334
	(0.104)	(0.109)	(0.107)	(0.109)	(0.110)	(0.152)	(0.157)	(0.156)	(0.158)	(0.158)
LOW_KNOW_SERV	-1.740***	-1.924***	-1.834***	-1.939***	-1.941***	0.385**	0.340**	0.387**	0.350**	0.349**
	(0.171)	(0.176)	(0.175)	(0.177)	(0.177)	(0.158)	(0.164)	(0.162)	(0.165)	(0.165)
KNOW_SERV	-0.658***	-0.909***	-0.925***	-1.016***	-1.004***	1.711***	1.646***	1.560***	1.568***	1.577***
	(0.119)	(0.124)	(0.125)	(0.127)	(0.127)	(0.129)	(0.136)	(0.133)	(0.137)	(0.137)
OTHER	-1.897***	-2.011***	-1.988***	-2.041***	-2.038***	0.323*	0.372**	0.331*	0.362*	0.364**
	(0.210)	(0.215)	(0.214)	(0.216)	(0.216)	(0.177)	(0.184)	(0.182)	(0.186)	(0.186)
o.LOW_TECH	-	-	-	-	-	-	-	-	-	-
Constant	-2.829***	-2.906***	-2.693***	-2.816***	-2.845***	-3.988***	-4.212***	-3.826***	-4.076***	-4.112***
	(0.211)	(0.220)	(0.216)	(0.221)	(0.221)	(0.260)	(0.273)	(0.268)	(0.276)	(0.276)
Observations	5,151	5,151	5,151	5,151	5,151	5,151	5,151	5,151	5,151	5,151
ll	-2452	-2282	-2354	-2262	-2258	-1993	-1802	-1870	-1775	-1772
chi2	954.2	1295	1150	1335	1342	485.7	868.2	731.4	921.7	927.4
r2_p	0.163	0.221	0.196	0.228	0.229	0.109	0.194	0.164	0.206	0.207
p	0	0	0	0	0	0	0	0	0	0

3.5.3 Logit regression models – radical and incremental innovation

In the next step, I took a closer look at the effects of organizational innovation on incremental (meaning a product that is new only to a company) versus radical (a product that is new for the entire market) product innovations. I further differentiated between new goods and new services, resulting in a total of four dependent variables. The logit regression models shown in Tables 8 and 9 confirm that the hypotheses 4a and 4b are correct, assuming that both internal organizational innovations and the introduction of new methods in establishing external relationships are important for radical as well as incremental product innovation (for the development of both new goods and new services).

Hypothesis 5 is also confirmed by the data, as in previous models; although the introduction of both types of organizational innovation has a negative effect on incremental as well as radical innovation, the dampening effect is relatively small and does not outweigh the benefits of combining organizational innovations with the expansion of a firm's network of partners.[8] But there are some interesting differences in the data. I can argue that the relevance of combining both types of organizational innovation is much higher for incremental product innovation (424% for new goods and 668% for new services) compared to radical product innovation (216% for new goods and 215% for new services). At the same time the importance of the expansion of new partners is very limited for radical product innovation compared to incremental. This result implies that firms that get engaged in both new methods for internal organizational management and new methods for organizing external relationships with other organizations have much higher probability in creating incremental innovations than radical innovations. Open innovation as well as internal reorganization are harder to wire to improve radical innovations.

Again, as in the case of the previous models, the size of the company is a strong predictor of product innovation, together with the intensity of research. Group membership is significant for the introduction of new goods, whereas it plays no role in the case of services. Age has no association in the models with the introduction of either new goods or new services.

[8] All the interaction term calculations can be seen in Table 11.

Table 9: Logistic regressions on incremental innovation

	NEFRM_GOODS					NEWFRM_SERV				
VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7	(8) Model 8	(9) Model 9	(10) Model 10
ORGINT		1.236***		0.982***	1.048***		1.695***		1.418***	1.504***
		(0.0815)		(0.0915)	(0.0951)		(0.102)		(0.114)	(0.118)
ORGEXR			1.215***	0.683***	1.367***			1.411***	0.683***	1.568***
			(0.0936)	(0.105)	(0.291)			(0.101)	(0.112)	(0.336)
ORGINT#c.ORGEXR					-0.773**					-0.965***
					(0.310)					(0.353)
GP	0.308***	0.187**	0.224**	0.162*	0.154	0.218**	0.0451	0.0842	0.00574	-0.00451
	(0.0903)	(0.0932)	(0.0927)	(0.0941)	(0.0941)	(0.102)	(0.106)	(0.106)	(0.108)	(0.108)
Ln_SIZE	0.367***	0.285***	0.300***	0.264***	0.266***	0.257***	0.136***	0.164***	0.111***	0.112***
	(0.0305)	(0.0315)	(0.0313)	(0.0318)	(0.0318)	(0.0348)	(0.0360)	(0.0359)	(0.0364)	(0.0364)
Ln_AGE	0.0834	0.0736	0.0781	0.0710	0.0704	0.0988	0.0826	0.0886	0.0785	0.0772
	(0.0690)	(0.0711)	(0.0709)	(0.0718)	(0.0717)	(0.0816)	(0.0844)	(0.0839)	(0.0852)	(0.0850)
RD_INTENSITY	4.849***	4.239***	4.575***	4.228***	4.197***	2.975***	2.399***	2.816***	2.421***	2.381***
	(0.655)	(0.622)	(0.639)	(0.623)	(0.625)	(0.551)	(0.561)	(0.549)	(0.559)	(0.563)
HIGH_TECH	0.707***	0.663***	0.659***	0.646***	0.639***	0.697***	0.609**	0.609***	0.577**	0.571**
	(0.175)	(0.181)	(0.179)	(0.182)	(0.183)	(0.229)	(0.238)	(0.236)	(0.240)	(0.239)
MEDIUM_HIGH_TECH	0.246**	0.205*	0.201*	0.186	0.184	0.0109	-0.0793	-0.0892	-0.118	-0.117
	(0.109)	(0.113)	(0.111)	(0.114)	(0.114)	(0.163)	(0.168)	(0.167)	(0.169)	(0.169)
MEDIUM_LOW_TECH	-0.142	-0.219*	-0.170	-0.219*	-0.222*	-0.0475	-0.140	-0.0835	-0.143	-0.145
	(0.113)	(0.117)	(0.115)	(0.117)	(0.117)	(0.167)	(0.171)	(0.170)	(0.172)	(0.172)
LOW_KNOW_SERV	-1.826***	-1.962***	-1.906***	-1.977***	-1.978***	0.311*	0.257	0.305*	0.264	0.262
	(0.201)	(0.205)	(0.204)	(0.206)	(0.206)	(0.171)	(0.176)	(0.174)	(0.177)	(0.177)
KNOW_SERV	-0.580***	-0.787***	-0.834***	-0.901***	-0.889***	1.447***	1.323***	1.260***	1.238***	1.247***
	(0.128)	(0.132)	(0.134)	(0.135)	(0.135)	(0.139)	(0.144)	(0.143)	(0.146)	(0.146)
OTHER	-1.864***	-1.931***	-1.935***	-1.961***	-1.959***	0.167	0.200	0.165	0.188	0.190
	(0.238)	(0.241)	(0.242)	(0.243)	(0.243)	(0.197)	(0.203)	(0.201)	(0.204)	(0.204)
o.LOW_TECH	-	-	-	-	-	-	-	-	-	-
Constant	-3.130***	-3.190***	-2.984***	-3.086***	-3.114***	-3.894***	-4.086***	-3.704***	-3.953***	-3.996***
	(0.228)	(0.235)	(0.233)	(0.236)	(0.237)	(0.278)	(0.290)	(0.285)	(0.292)	(0.293)
Observations	5,151	5,151	5,151	5,151	5,151	5,151	5,151	5,151	5,151	5,151
ll	-2188	-2070	-2105	-2049	-2046	-1752	-1599	-1659	-1580	-1577
chi2	717.2	952.9	882.2	995.5	1001	306.4	614.0	493.5	651.5	658.0
r2_p	0.141	0.187	0.173	0.195	0.197	0.0804	0.161	0.129	0.171	0.173
P	0	0	0	0	0	0	0	0	0	0

Table 10: Logistic regressions on radical innovation

	NEWMKT_GOODS					NEWMKT_SERV				
VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7	(8) Model 8	(9) Model 9	(10) Model 10
ORGINT		1.293***		1.103***	1.164***		1.492***		1.182***	1.218***
		(0.0877)		(0.0976)	(0.101)		(0.115)		(0.130)	(0.135)
ORGEXR			1.091***	0.509***	1.163***			1.337***	0.722***	1.100***
			(0.0973)	(0.108)	(0.311)			(0.112)	(0.125)	(0.410)
ORGINT#c.ORGEXR					-0.729**					-0.411
					(0.330)					(0.429)
GP	0.283***	0.157	0.210**	0.139	0.132	0.188	0.0401	0.0690	0.00452	0.000189
	(0.0966)	(0.0996)	(0.0986)	(0.100)	(0.100)	(0.117)	(0.120)	(0.120)	(0.121)	(0.121)
Ln_SIZE	0.340***	0.252***	0.275***	0.234***	0.235***	0.314***	0.207***	0.220***	0.179***	0.179***
	(0.0325)	(0.0335)	(0.0331)	(0.0337)	(0.0337)	(0.0396)	(0.0406)	(0.0405)	(0.0409)	(0.0409)
Ln_AGE	0.120	0.113	0.118	0.112	0.111	0.128	0.119	0.126	0.120	0.118
	(0.0742)	(0.0764)	(0.0759)	(0.0769)	(0.0768)	(0.0937)	(0.0959)	(0.0960)	(0.0969)	(0.0968)
RD_INTENSITY	4.223***	3.715***	4.019***	3.703***	3.666***	3.596***	3.140***	3.450***	3.162***	3.145***
	(0.601)	(0.587)	(0.590)	(0.585)	(0.586)	(0.578)	(0.581)	(0.571)	(0.579)	(0.581)
HIGH_TECH	0.945***	0.914***	0.903***	0.899***	0.894***	1.115***	1.053***	1.046***	1.026***	1.023***
	(0.178)	(0.185)	(0.181)	(0.185)	(0.185)	(0.237)	(0.244)	(0.242)	(0.245)	(0.245)
MEDIUM_HIGH_TECH	0.270**	0.223*	0.223*	0.205*	0.204*	0.178	0.101	0.0896	0.0649	0.0645
	(0.116)	(0.121)	(0.119)	(0.121)	(0.121)	(0.183)	(0.187)	(0.186)	(0.188)	(0.188)
MEDIUM_LOW_TECH	0.0229	-0.0455	0.00395	-0.0448	-0.0474	0.0928	0.0204	0.0649	0.0200	0.0189
	(0.120)	(0.123)	(0.121)	(0.124)	(0.124)	(0.188)	(0.191)	(0.191)	(0.192)	(0.192)
LOW_KNOW_SERV	-1.601***	-1.724***	-1.655***	-1.728***	-1.730***	-0.202	-0.271	-0.225	-0.266	-0.267
	(0.211)	(0.215)	(0.214)	(0.215)	(0.215)	(0.229)	(0.232)	(0.232)	(0.233)	(0.233)
KNOW_SERV	-0.550***	-0.760***	-0.775***	-0.846***	-0.836***	1.523***	1.387***	1.324***	1.292***	1.295***
	(0.140)	(0.144)	(0.145)	(0.146)	(0.146)	(0.159)	(0.163)	(0.163)	(0.165)	(0.165)
OTHER	-2.212***	-2.273***	-2.267***	-2.293***	-2.290***	-0.163	-0.148	-0.174	-0.161	-0.160
	(0.317)	(0.320)	(0.320)	(0.321)	(0.321)	(0.255)	(0.259)	(0.258)	(0.260)	(0.260)
o.LOW_TECH	-	-	-	-	-	-	-	-	-	-
Constant	-3.413***	-3.499***	-3.273***	-3.414***	-3.439***	-4.586***	-4.756***	-4.404***	-4.615***	-4.631***
	(0.246)	(0.254)	(0.250)	(0.255)	(0.255)	(0.323)	(0.333)	(0.329)	(0.336)	(0.336)
Observations	5,151	5,151	5,151	5,151	5,151	5,151	5,151	5,151	5,151	5,151
ll	-1974	-1861	-1913	-1850	-1848	-1416	-1323	-1348	-1306	-1306
chi2	604.4	830.0	725.6	852.1	856.6	328.8	514.4	464.9	547.9	548.8
r2_p	0.133	0.182	0.159	0.187	0.188	0.104	0.163	0.147	0.173	0.174
p	0	0	0	0	0	0	0	0	0	0

Table 11: Interaction term calculations

NEWGOODS			**NEWFRM GOODS**			**NEWMKT GOODS**		
		Probability			Probability			Probability
ORGINT	ORGEXR		ORGINT	ORGEXR		ORGINT	ORGEXR	
0	0		0	0		0	0	
1	0	241 %	1	0	185 %	1	0	201 %
0	1	299 %	0	1	292 %	0	1	66 %
1	1	484 %	1	1	423 %	1	1	216 %
NEWSERVICES			**NEWFRM SERVICES**			**NEWMKT SERVICES**		
		Probability			Probability			Probability
ORGINT	ORGEXR		ORGINT	ORGEXR		ORGINT	ORGEXR	
0	0		0	0		0	0	
1	0	345 %	1	0	350 %	1	0	238 %
0	1	366 %	0	1	380 %	0	1	11 %
1	1	654 %	1	1	668 %	1	1	215 %

Table 12: Post estimation VIF test

Variable	**VIF**	**1/VIF**
Ln_SIZE	9.61	0.1040
Ln_AGE	8.05	0.1243
GP	2.12	0.4711
MEDIUM_HIGH_TECH	1.73	0.5778
KNOW_SERV	1.69	0.5905
MEDIUM_LOW_TECH	1.66	0.6040
LOW_KNOW_SERV	1.44	0.6925
OTHER	1.32	0.7566
ORGEXR	1.31	0.7652
HIGH_TECH	1.15	0.8689
RD_INTENSITY	1.06	0.9442
MEAN	2.83	

3.6 DISCUSSION AND CONCLUSIONS

This chapter examines the relationship between organizational innovation and product innovation. I use a sample of 5,151 firms covered by the Community Innovation Survey 2010 in the Czech Republic. I distinguish between measures of

organizational innovation (changes in internal organizing procedures) and open innovation (new ways of organizing external relations), which are supposed to play a role in increasing the probability of introducing new products onto the market. Moreover, I analysed the effects of the organizational innovation and open innovation on the probability of product innovation using four sub-samples that distinguished between new-to-the-market and new-to-the-firm innovative companies and between companies introducing new goods and new services onto the market. I also looked at the interaction effect of the two independent variables. In exploring these issues the chapter provides fresh empirical evidence for the relationship between internal organizational innovation, open innovation and the innovativeness of the firm.

The main findings contribute to the product innovation literature in several ways. First, I bring empirical evidence on the relationship between various activities aimed at changing the organizational arrangements and the propensity to innovate. Second, I'm not constrained by any specific industry but I'm able to show results for firms innovating both in manufacturing as well as in the services industries. Third, I made a distinction between incrementally and radically innovations. Fourth, I distinguish between innovations in internal procedures and new methods of organizing external relations to gain a better understanding of the degree to which an organizational innovation still brings benefits to a firm, measuring whether the relationship between change and product innovation is mainly influenced by changing internal procedures and adopting new methods to team up with external partners.

The results show that successful product innovation requires changes either in the internal procedures and decision-making processes on the one hand and in the methods used for organizing external partnerships on the other hand. This finding applies to product innovation in the manufacturing as well as service industries. The results further show that when firms introduced both types of innovation activity then the probability of introducing a new product onto the market is even higher. This implies that there is a strong positive relationship between organizational innovation and open innovation. There is an interesting difference between incremental and radical product innovation in connection with external partnerships, indicating that firms that are still not very open

to collaboration with external partners on products which are radically new. On the other hand, they are very used to involve third parties in incremental improvements to their product lines. I should therefore differentiate among various types of innovations and the "quality" of product innovation as the effects vary significantly, depending on the degree of product innovation a firm embraces. On a general level the results also show that large, R&D-intensive, multinational companies have a significantly higher probability of introducing new products onto the market than their smaller counterparts that are not so active in R&D.

The results have some clear managerial implications. First, as both organizational innovation as well as open innovation are consistently associated with a significantly higher propensity of product innovation, independently of the industry and type of innovation, there is a need to find the right organizational setting for innovation. The firm has to continuously search for changes in its working procedures and business practices in order to fit the market demands and make commercially viable products. Second, changes in organizational arrangements (either in internal procedures or external relationships) of a firm should correspond with the needs in the product innovation domain. That is, internal decision-making procedures and the organizational structure may be in line with the needs for new product innovation but if there is a lack of formal and informal ties with external partners (either science-based or market-based), then a firm's innovativeness will be suboptimal. Or vice versa, if a firm has many external relationships with a continuous inflow of new ideas and knowledge, but its internal procedures are not adapted, then I can expect that product innovation will be suboptimal. Organizational innovations should be thoroughly planned, implemented step-by-step, and evaluated continuously in order to avoid friction and stressful situations within the organizational structure.

3.6.1 Limitations and further research

While this chapter provides important contributions and shows that changes in organizational arrangements can be drivers of product innovation, some questions remain unanswered, providing exciting opportunities for further research. The findings highlight that changes to both internal processes such as business practices and new methods of organizing work responsibilities and new

methods of organizing external relations are significant predictors of product innovativeness if implemented separately, and that if a firm implemented both at the same time the probability of introducing a new product onto the market was even higher. The results indicate one interesting difference. When companies introduced a radically new product onto the market then changing its external relations was of almost no relevance compared to incrementally new products. And although I provided an explanation for this phenomenon, this could provide an interesting opportunity for future research endeavours to investigate how open firms are to involvement and collaboration with third parties on various product development projects differentiated by their newness. Another problem that arises is the capacity of managers to maintain and control all the organizational innovations at the same time. Hence, it might be more difficult to handle changes of different types (e.g. internal procedures vs. external relationships) than those of one type. Therefore, it is interesting to shed light on and thus add to the innovation process literature by examining whether the (coordination, transaction cost) effort increases when a firm engages in e.g. organization-wide changes related to improving its innovativeness and to compare it to the effort involved in handling carefully planned incremental changes implemented step by step. Thus, future research could investigate firms' approaches to different kinds of organizational innovations and how they correspond to the needs of new product development. Furthermore, the findings do not differentiate the stage and scale of the organizational innovation.

Additionally, the empirical evidence presented in this chapter article should be considered carefully and influenced by the indicators 'organizational innovation', 'product innovation', and 'radical and incremental innovation', adopted by CIS (Evangelista & Vezzani, 2010). The data collected in innovation surveys is quantitative, subjective, censored, and cross-sectional in nature, which does not allow for strong causal claims (Mairesse & Mohnen, 2010). In this vein, I lack project-level information and hope that future research can look in more detail into the causal effects of organizational innovation at a project level. Another limitation of this study lies in the fact that the survey is subjective and based on the assertions of individual firms. Although the reliability and validity of the survey have been established, some questions may remain slightly subjective and rely

on the perception of the respondent and his/her involvement in innovation activities.

4 FIRM-LEVEL DETERMINANTS OF INNOVATION PROJECT TERMINATION

4.1 INTRODUCTION

"Companies that don't innovate die" (Chesbrough, 2003). Innovation is one of the most cited and prominent drivers determining the performance and survival of a firm (e.g. Geroski et al., 1993; Audretsch, 1995). Hence, innovation activity is the necessary precondition for achieving long-term competitive advantage (Bard et al., 1988). The pressure to innovate for firms in high-tech industries results in significant investments in new product development (Balachandra et al., 1996; Raelin & Balachandra, 1985). Despite the vast number of innovation success stories, Asplund & Sandin (1999) and Cozijnsen et al. (2000) argue that few ideas ever reach the market or are commercially viable (Raelin & Balachandra, 1985). Indeed there are many obstacles hampering innovation activities (e.g. costs, human capital/knowledge, markets, financial barriers, and regulations) (Galia & Legros, 2004; D'Este et al., 2012; Blanchard et al., 2013). The more experienced a firm becomes in dealing with these barriers, the better its chances for future success (Leoncini, 2016). Experience also fosters the development of the ability to continue innovation projects with a high chance of success while terminating those that are likely to fail.

The decision to terminate an ongoing innovation project before it achieves its goals is difficult because it is usually considered as accepting failure, which few managers are willing to acknowledge (Kumar et al., 1996). A manager who can make an early and correct decision to terminate an innovation process can save time, money, and other resources, which can be redirected towards more promising and potentially successful activities. In his study, Leoncini (2016) shows '*that an unsuccessful innovative activity might ultimately*' (p. 385) lead to positive returns, which is in line with studies emphasising the benefits of a terminated innovation project. In an ever more complex and fast-changing environment, in a world of rapid technological change and marketplace turbulences, the effects of these changes on innovation process management and termination are underexplored. This is despite the fact that termination decisions are one of the most difficult and important decisions faced by managers. Therefore, it is necessary to understand the underlying organisational characteristics influencing

the termination of unfeasible innovation processes with poor prospects early on – while continuing more promising projects. Despite a tremendous amount of research over the past 30 years, the literature is far from demonstrating a cohesive understanding of the determinants of success and failure in innovation projects (van der Panne et al., 2003). Previous studies focused on different sets of factors and there are significant differences regarding the relevance of single factors in explaining the termination of innovation activities. In sum, due to heterogeneity in samples, industries investigated, and methods used, it is difficult to make valid comparisons between these studies.[9] The lack of integration among the different insights causes gaps in understanding. Therefore, in this chapter I add an additional level – the firm level – to provide a starting point for other researchers to take a multi-level approach for studying the termination of innovation activities.

I complement previous project-level research by studying the factors associated with innovation termination at the firm level – such as organisational innovation and marketing innovation. The research question is: 'What are the firm-level factors determining the termination of innovation endeavours by firms?' This question is important since many firms spend a significant budget on innovation projects that do reach commercialisation. Firstly, these expenditures embody

a sizable investment for many firms and may have a significant impact on their current and future financial position, as well as on their ability to compete technologically. Secondly, projects often entail company-wide commitments that translate into large opportunity costs if improperly managed (Bard, 1988). Thirdly, being able to recognise unfeasible projects early on avoids sunk investments and releases resources that can be invested in more profitable projects.

In this chapter, I aim to throw light on the firm-level factors influencing the termination of innovation activity.

I use a sample of 4,385 firm observations to understand their innovation behaviour, and specifically, the firm-level factors associated with innovation

[9] Samples differ as some studies investigate a specific industry, and others cover several industries. Methods differ, as some studies are qualitative while others are quantitative. The methods applied often determine the factors used for project termination.

termination. I find that firm size, R&D activity, organisational innovation, marketing innovation, and market internationalisation are significantly positively associated with innovation termination.[10] The research contributes to the literature studying the success and failure factors of innovation endeavours by firms in general (Kim & Miner, 2007), and the literature dealing with innovation project termination in particular (Pinto & Mantel, Jr., 1990). In doing so, I raise researcher and practitioner awareness regarding the underlying firm-level factors driving the termination of innovation endeavours. Based on the research, firms can analyse their innovation project management and spending behaviour. In this chapter I argue that the termination of innovation projects (although the projects themselves can be considered as failures) is a laudable management practice and an effective detection of such failures is necessary to avoid waste of time and high costs in continuing projects. Thus, firms can prevent overspending on innovation, which the literature found to be correlated with innovation project termination (Raelin & Balachandra, 1985; Peck et al., 2015; Wallin & Gilman, 1986; Balachandra, 1996). In sum, this chapter advocates for termination of a project as a valuable learning opportunity and a proper way of handling less promising innovation projects.

The chapter is organised as follows: Section 4.2 reviews the theoretical literature on the subject and Section 4.3 presents hypotheses for empirical testing; Section 4.4 describes the data, the econometric method used, and the measurement of main variables; Section 4.5 presents the results, and Section 4.6 concludes with a discussion of the main findings and provides some implications for further research.

4.2 LITERATURE REVIEW

I provide below a review of the relevant literature on innovation management focusing on the determinants of success and failure in innovation activities and the barriers to innovation. I then present dynamic capabilities as the framework for analysing innovation process management in firms with regard to the termination of innovation endeavours.

[10] I mainly refer to correlations with the analysis since the data is cross-sectional. Nonetheless, I interpret that firms with certain characteristics are more likely to terminate projects.

4.2.1 Success/failure in innovation endeavours

One important stream within the innovation management literature deals with understanding the critical success factors during the innovation process. '*As innovative activity is inherently uncertain, it often results in termination or even failure*.' (Leoncini, 2016) (p. 376). Several studies on firms explicitly identify specific success (van der Panne et al., 2003, Lhuillery & Pfister, 2009, Freeman et al., 1972, Cooper, 1980, Maidique & Zirger, 1984, Pinto & Slevin, 1987) and failure factors (Pinto & Mantel Jr., 1990) driving innovation performance. Van der Panne et al. (2003) study factors influencing the viability of a new product and classify them into four different groups: firm-related factors; project-related factors; product-related factors; and market-related factors. They further differentiate firm-related and project-related factors as determinants of technological viability, while product-related and market-related factors are described as determinants of commercial viability. Firm-related factors driving technological success are: firm culture (Calantone et al., 1993, Lester, 1998); experience with innovation (Stuart & Abetti, 1987, Bessant & Buckingham, 1993, Wind & Mahajan, 1988, Cohen & Levinthal 1990); characteristics of the R&D team such as interdisciplinarity (Rothwell, 1992, Page, 1993, Roure & Keeley, 1990, Cooper, 1983); and strategy towards innovation (Cottam et al., 2001, Gobeli & Brown 1987). Previous studies are discordant about the influence of organisational structure and R&D intensity (van der Panne et al., 2003, Cohen & Levinthal, 1990) on innovation project success.

Project-related factors affecting successful completion of an innovation project are the complementarity of the project with the firm's resources (Stuart & Abetti 1987, Cooper, 1993, Zirger & Maidique, 1990) and management style (Cozijnsen et al., 2000, Cooper & Kleinschimdt, 1987, Cooper & Kleinschimdt, 1995). Finally, top management support is argued to be an ambivalent factor for innovation project viability.

With respect to the product's commercial viability, two product-related factors (i.e. price Maidique & Zirger, 1984 and quality Calantone et al., 1993, Roure & Keeley, 1990, Link, 1987) and two market-related factors (i.e. market concentration Roure & Keeley, 1990 and market introduction Maidique & Zirger,

1984, Hopkins, 1981) are acknowledged as success factors.[11] Previous studies address barriers to innovation (e.g. costs, missing access to human capital/knowledge, markets, organisational inertia, financial barriers, and regulatory obstacles). Particular attention has been paid to financial constraints as these can apparently be major barriers to innovation (Canepa & Stoneman, 2005, Mohnen & Roller, 2005, Mohnen et al., 2008, Garcia-Vega & Lopez, 2010, Savignac, 2008). The financial capacity of a firm seems to have a significant impact on the early stages of innovative projects (stopping projects prematurely or seriously delaying projects), whereas they do not affect innovative activities already well underway (Canepa, A. & Stoneman, P., 2005). Additionally, firms collaborating on innovation have been found to abandon or delay their innovation projects due to difficulties in partnerships (Lhuillery, S. & Pfister, A., 2009). In contrast, firms with a certain level of absorptive capacity are less likely to experience failures in their innovative activities (Lewin, A.Y. et al., 2011). Although the decision to terminate an innovation activity can occur at any point along the pipeline, it frequently happens at the end of the development phase. To grasp the significance of a termination decision, a brief explanation of the innovation process and related barriers may be helpful (Raelin & Balachandra, 1985).

Typically, an innovation process describes a pre-defined sequence of phases from idea generation to problem-solving to commercialisation (Salerno et al., 2015, Rothwell & Robertson, 1973).[12] Each of these phases comprises inherent risk and reviews in terms of stage-gate processes (Cooper, 2008). A project will only be continued if it meets all the deliverables at the phase/stage gate. Iterative feedback further augments project development during these stages. Termination risks associated with the idea generation phase – the phase in which a new product or process concept with the functionality and specification criteria is defined (Manzini & Lazzarotti, 2015) – comprise issues regarding intellectual property held by other entities, internal competition from other more promising

[11] External factors affecting the success/failure of an innovation project are less relevant for the purpose of the study. I only possess internal firm information. However, I mention them here for completeness.
[12] Saren (1984) provides a review of different descriptive innovation process models. I conceptualise the stages according to Utterback (1971); Utterback (1974) and Tushman (1977).

ideas, project cost forecasts that exceed budget, and insufficient in-house knowhow to complete the project. In the problem-solving phase, innovation investments are made, R&D is conducted, the close-to-optimal design of the innovation is developed, and critical design components are shared. Therefore, termination of a project in this phase may be due to insufficient in-house technical and production knowledge, insufficient financial or physical resources, insufficient internal support if the prototype does not live up to its expectation or deliver the expected results and/or benefits, a lack of support from top management, lack of commitment from project workers, higher development costs than initially budgeted, and issues regarding intellectual property held by other entities.

Problems that cause the termination of a marketable product in the commercialisation phase relate to incorrect understanding of customer needs, product defects, lack of an effective marketing effort, higher than expected product launch costs, strong competition, bad timing, a product price that is too high, insufficient marketing efforts, radicalness of the new product (newness to firm and/or to market), and sales force or distribution weaknesses (Cooper, 1983).

Within the innovation process literature, research provides a long track record of the drivers of innovation project termination (Brockhoff, 1994, Tadisina, 1986, Rubenstein et al., 1976, Holzmann, 1972, Teece et al., 1997).

In sum, several studies have identified factors to distinguish between successful and unsuccessful innovation projects (Brockhoff, 1994). Literature shows that the success or failure of an innovation project is determined by a combination of factors rather than by any single factor. Moreover, previous studies present different discriminant factors of success and failure projects, but there is no study containing completely the same set of factors. Hence, comparability across studies is difficult. For example, Tadisina (1986) identifies 23 variables grouped into five categories: (1) uncertainty at project initiation; (2) pressure to start project; (3) expected impact; (4) science and technology areas; and (5) intention to protect project outcomes. Balachandra (1996) groups the determinants into seven categories, namely: strategic; economic; environmental; technological; operational; behavioural; and organisational. Rubenstein et al. (1976) classify the variables into six categories as follows: factors related

to impetus for innovation; factors related to project decision; factors related to project structure and process; factors related to organisational structure and process; factors related to outcomes; and other factors (Kumar et al., 1996). Raelin & Balachandra (1985) suggest that strategic parameters of the high-technology research environment (such as high rates of product turnover, high market share, and small size) were found to lead to continuations; whereas infancy stage product life cycle and innovative versus aligned research strategy led to terminations. Holzmann (1972) argues that innovation projects should be terminated when they are proven technically unfeasible or economically unsound (Kumar et al., 1996). Furthermore, Balachandra (1996) investigates determinants of innovation project termination in an international context and finds a remarkable consistency across the set of 27 factors discriminating between successful and failing R&D projects in Japan, UK, USA, and Germany.

Despite a vast number of studies detecting various project-level termination factors, the firm-level determinants of innovation determination remain underexplored. Understanding what drives the termination of innovation endeavours at the firm level may provide complementary insights to the non-comparable, project-level factors that were identified by previous research. I can thus derive some more generalizable and relevant factors driving the termination of innovation endeavours.[13] Although, firm-level factors are often independent of the projects themselves, they nevertheless exert an indirect influence on the overall firm innovation project management process. By focusing on firm-level innovation termination, this study provides firms with support to fully exploit their innovative potential as they continue to eliminate obstacles to their innovative activity, and hence maximise their innovative efforts.

4.2.2 Dynamic capabilities

Firms in today's ever more complex and fast changing business world need the dynamic capabilities – in contrast to ordinary capabilities – to be able to react quickly and flexibly to internal and external changes. Hence, the dynamic capabilities of a firm represent an essential element of innovation process

[13] In the context of this study, I understand successful innovation as an activity that is not discontinued at any stage. I interpret the termination of an innovation activity as a deviation from an expected outcome (i.e. successful commercialisation or introduction of a new product/process).

management. As discussed above, innovation management requires timely and flexible decision-making to address rapidly changing environments such as in the case of innovation termination. In inherently uncertain situations, such as the innovation process, dynamic capabilities represent a new approach to manage deep (unqualifiable) uncertainty. Dynamic capabilities closely relate to the management capability to effectively coordinate and redeploy internal and external competences (Teece et al., 1997). Coupled with a validated strategy, dynamic capabilities enable an organisation to change in a manner that supports evolutionary fitness and sustainable competitive advantage. A company should not be just focused on control and oversight, but on thinking creatively about new projects and business opportunities and executing them proficiently. Termination of an on-going activity requires agile and fast reactions to unforeseen or unexpected change and has thus been discussed in the context of dynamic capabilities (Teece et al., 1997, Winter, 2003, Eisenhardt & Martin, 2000). Particularly, innovation termination entails a transformational culture and strong leadership that can realign tangible and intangible assets, strategy, structure, and processes.

Moreover, dynamic capabilities are not only beneficial in dealing with innovation termination, they can also be enhanced by the termination of innovation activities. In turn, not developing dynamic capabilities after the discontinuation of innovation activities can also be detrimental for the recovery, profitability, and survival of a firm after experiencing such a situation.

4.3 HYPOTHESES

In this section, I discuss the determinants of innovation project termination and develop testable hypotheses. The most important factors leading to successful innovation outcomes are deemed to be firm size, age, experience with innovation projects, existence of an R&D department, and interfirm collaboration. Previous research has also identified several barriers to successful innovation such as missing access to know-how on markets or technologies (Galia & Legros, 2004), lack of finance (Katila & Shane, 2005), organisational inertia (Hannan & Freeman, 1984), or regulation (d'Este et al., 2012). I complement these previous studies by adding relevant firm-level determinants associated with innovation termination

such as internal/external R&D, organizational innovation, level of internationalisation, and marketing innovation.

4.3.1 Firm size

In contrast to SMEs, larger firms can employ economies of scale and scope when it comes to innovation projects and thus create transaction cost benefits. Established firms have the financial capacity to generate product innovation projects with substantial economic benefits ('valuable patents') (Allison et al., 2004, Harhoff et al., 2003, Hussinger, 2006). They often also have established routines to effectively screen the internal and external environment of the firm and analyse whether an on-going project is still viable and promising. Nonetheless, large firms usually face decreasing returns to scale in innovation projects (Hagedoorn & Wang, 2012). Larger firms are less efficient than smaller firms due to greater bureaucracy and routinisation. Additionally, reduced managerial attention to innovation, and a stronger focus on ordinary capabilities and operational routines leads to lower innovative efficiency for firms (Hitt et al., 1990), as well as the risk of inventive opportunities being exhausted over time (translating into a lower rate of commercialisable products per innovation project started) (Hagedoorn & Wang, 2012, Griliches, 1990, Hausman et al., 1984). According to the resource-based view, smaller firms possess fewer resources to invest in new innovation projects (Wernerfelt & Karnani, 1987, Leiponen & Byma, 2009).

Hence, smaller firms might hold on to innovation projects longer. These firms will only start an innovation project when they are convinced that it might be a success. Larger firms can easily neglect a project that does not perform according to expectations as these firms possess more resources that can be invested in other projects. I would expect larger firms to be more likely to cancel an on-going innovation project than a small firm.

H1: Firm size is positively associated with the likelihood of terminating an innovation project.

4.3.2 Internal and external R&D

Investing in R&D is associated with an increase in total innovative output (see e.g., Cassiman & Veugelers, 2006, Lokshin et al., 2008, Rothaermel & Hess,

2007). Engaging in research activities enables firms to explore, develop new competences, and capabilities. At the same time, firms may also develop new products or processes that have a significant impact on their financial performance. Previous research has differentiated between internal and external R&D (e.g. Lokshin et al., 2008, Veugelers, 1997). In the realm of open innovation, several studies suggest that firms increasingly rely on external sources of knowledge in innovation and thus simultaneously pursue internal and external R&D (Chesbrough, 2003, Chesbrough, 2006). External R&D can thus be an important source for improving and accelerating internal R&D. In turn, internal R&D and building absorptive capacity (Cohen & Levinthal, 1990) are important for recognising, assimilating, and exploiting relevant external knowledge. With sufficient in-house knowledge, a firm can effectively absorb external spillovers (Lokshin et al., 2008, Veugelers, 1997). Although some studies argue that internal and external R&D are substitutes (Audretsch et al., 1996), the open innovation literature clearly suggests complementarity between internal and external R&D (Hagedoorn & Wang, 2012, Cassiman & Veugelers, 2006, Lokshin et al., 2008, Beneito, 2006). Hence, combining internal and external R&D significantly contributes to productivity growth due to '*involvement in multiple technological trajectories, research directions that cannot be developed simultaneously (at sufficient speed), and in-house and external development skills exploiting in-house research activities more effectively*' (Lokshin et al.: p. 401). Moreover, Brouwer et al. (1999) find that the relationship between internal/external R&D and innovative output is influenced by factors such as regional knowledge spillovers, demand-pull effects, or differences in technological opportunity. Such factors can explain that R&D input and innovative output are far less correlated than one would intuitively expect. Thus, a similar line of arguments as above can be made here. Investing in many internal and external innovation projects simultaneously requires more formalisation to monitor the status of the projects. In that line of argument, companies conducting more R&D will become more formalised, and therefore termination will be decided on more objective criteria. In contrast, firms with few R&D investments have no formalised system in place, and will continue projects as long as managers believe in them. This typically leads to over-commitment to poorly performing innovation projects (Staw & Ross, 1987). The "escalation of commitment" (Staw, 1976) phenomenon describes the

tendency of managers to stick to previously selected course of action because "too much too quit" has been invested into the objectively underperforming project. Sleesman et al. (2012) provided an overview of various explanations for this behaviour from theoretical perspective (i.e. self-justification theory, self-presentation theory, prospect theory and agency theory) as well as a set of social (i.e. norms, group identity), psychological (i.e. ego threat, time investment, proximity to project completion) and project (i.e. decision risk, opportunity cost information) determinants of escalation. Therefore, investing more resources in R&D usually increases the risk of innovation project termination. I formulate the following hypothesis:

H2: Conducting internal and external R&D simultaneously is positively associated with the likelihood of terminating an innovation project.

4.3.3 Organizational innovation

Organizational innovation is important for the economic sustainability of firms. Building dynamic capabilities through organisational innovation is a '*necessary precondition for technological innovation*' (Lam, 2005). Thus, a firm's technology base is necessary – but it is not the only precondition of market success. There is a need for new capabilities and organisational arrangements within companies to fully exploit and manage technological innovation activities.

The ability to renew means that a firm can constantly evolve due to proactive search for and utilisation of new knowledge and innovations to recombine its core competencies and/or make changes in its product market domain (Floyd & Lane, 2000). But such a change never comes easy as strong and enduring inertial forces unleashed by ossified competencies are difficult to overcome. The firm's structures, procedures, and relationships continue to reinforce prior patterns of behaviour and thus resist developing new ones. As a result, organisational changes sometimes result in upheavals and dissatisfaction, and possibly even in resignations and dismissals among employees – also known as the 'not-invented-here' syndrome (Katz & Allen, 1982). In sum, organizational innovation can take different forms but changes usually occur in strategic direction, structure, processes, or tasks (Armbruster et al., 2008). Becoming more flexible and agile in times of increasing turbulence and complexity is critical in the long-run. Organizational innovation requires employees to concentrate on the changes

before focusing on any innovation project. Sometimes employees are allocated to a new project, team, or department that requires additional time and adjustment. Due to these organisational changes, the priorities of firms may alter or need to be adapted to current needs and so they thus abandon current innovation projects in the short-run.

Despite a vast amount of literature arguing that organizational innovation is beneficial for achieving long-term competitive advantage (Teece et al., 1997), any change within the organisational arrangements and routines of a firm makes it vulnerable and may have short-term negative effects on the innovation process.

H3: Organizational innovation is positively associated with the likelihood of terminating an innovation project.

4.3.4 Level of internationalisation

A firm's level of internationalisation refers to the number of markets a firm actively operates in and assuming that cultural and organisational barriers increase with the number of markets a firm has locations in or sells its products to.[14] Existing literature mainly deals with the effects of the level of internationalisation on firm performance (Hitt et al., 1997, Lu & Beamish, 2004), but findings have to some degree been inconsistent and contradictory. Some scholars have pointed out benefits of internationalisation such as efficient tacit knowledge transfer (Kogut & Zander, 1993), access to diverse ideas from multiple market and cultural perspectives (Kotabe, 1990), and scale and scope economies (Kobrin, 1991). However, other studies suggest lower firm performance due to the uncertainty of various policy environments (Delios & Henisz, 2003), increased managerial constraints (Grant, 1987), and the liability of foreignness (Hymer, 1960). According to transaction cost theory, complexity due to internationalisation also associates with higher transaction costs created by language and cultural obstacles which can only partly be justified by economies of scale and scope. Operating on an international scale (i.e. number of markets a firm operates in) also signifies the necessity to stay at the technological frontier and with the need to compete with the best innovator. Hence, firms might be

[14] In this chapter, I define market complexity by the number of markets a firm operates in – including local/regional markets, national markets, other EU, EFTA or EU candidate countries, and all other countries. Thus, complexity increases with growing internationalisation.

more likely to explore different innovation projects simultaneously. Thus, firms might take greater risks to compete on a larger international level. Operating at the technological frontier also increases the risk of having to terminate some of the ongoing innovation projects early on. Moreover, operating on a highly international scale also increases the level of competition against more and stronger innovators. Hence, the more markets a firm serves, the more competition it will face from firms with strong skills in research and innovation. To thrive in a highly competitive international context, a firm must be at the forefront of technology as well as possess dynamic capabilities. As a result, the more a firm operates internationally, the stronger its (dynamic) learning capabilities and the more comfortable it should be with abandoning projects that do not seem to be working. Additionally, resources are limited and need to be balanced between investing in daily operating routines or in promising future activities at an international level. Market internationalisation increases complexity for firms but also provides the cash flow required to engage in costly and risky innovation at an efficient scale (Schumpeter, 1950, Acs & Audretsch, 1987). However, such risk heavily depends on the industry and technology a firm operates in (Scherer, 1965). Therefore, the more complex the market, the more likely that a firm will interrupt an on-going innovation project because current and daily processes have greater priority than future innovation projects.

H4: Market internationalisation is positively associated with the likelihood of terminating an innovation project.

4.3.5 Marketing innovation

There are few references about marketing innovation in connection with product or process innovation. Scholars often examine the relationships between market orientation (which focuses on market intelligence gathering and dissemination within the organisation and responsiveness to such information Kohli & Jaworski, 1991) and business performance (Slater & Narver, 2000, Pelham, 2000). The links between market orientation and innovativeness have also been explored by researchers (Verhees & Meulenberg, 2004). In this study, I deal with practical marketing activities and their innovations. Therefore, I'm interested in exploring the relationships between marketing innovations (such

as new or changing strategies for product promotion, pricing, and sales channels) and their impact on product and/or process innovation.

Empirical research has shown that the innovation-marketing fit (meaning how companies exploit their marketing capabilities) has a positive impact on the market success of newly launched products (Atuahene-Gima, 1996).

Therefore, marketing capabilities should be positively associated with product innovation as companies can harvest information from the market and predict customer preferences. As Vorhies et al. (2009) show marketing capabilities also positively mediate the product-market strategy and the derived business unit performance relationship. I perceive marketing capabilities here as an 'executive' arm of market orientation because firms need to have the right capabilities to exploit the potential presented in market orientation activities. The better the market capabilities of a firm, the lower the risk of product innovation termination. Therefore, I hypothesise:

H5: Marketing innovation is negatively associated with the likelihood of terminating an innovation project.

4.4 METHOD

4.4.1 Data

Community Innovation Surveys (CIS) are conducted in all European Union (EU) member states (sometimes even at a regional level) and are based on the Oslo Manual recommendations (OECD, 1992, 1996, 2005). Innovation surveys exist under different acronyms in many other OECD countries and also in emerging, transition, and developing countries. By and large the surveys have the same structure and the same questions regarding innovation, but there are some differences between countries – even within the CIS – regarding content, formulation, and the ordering of the questions (Mairesse, J. & Mohnen, P., 2010). As a result, CIS data is frequently used (but mainly includes information from one survey in each country) and CIS data is therefore cross-sectional in nature. As discussed above, CIS data has been extensively exploited in numerous ways and researchers now recommend using CIS data to combine different countries or in longitudinal studies (Mairesse, J. & Mohnen, P., 2010). Although this data enables a comparison of national systems of innovation (Evangelista, R. et al.,

2001) only a few studies have started to incorporate more than one country in their analyses. A few notable studies include contributions by Harrison et al. (2014), Czarnitzki & Lopes Bento (2012), Horbach et al. (2013), Freitas et al. (2011) and Therrien & Mohnen (2003).

Additionally, Leoncini (2016) performs a set of empirical estimates on the effect of innovation failure based on a large dataset of innovative firms from 16 countries drawn from the 2008 Community Innovation Survey.

4.4.2 Sample

In this chapter, I use the German and Czech Community Innovation Survey 2010 (CIS 2010) which includes the core Eurostat CIS and additional topics for firms in Germany. The study is conducted every year and contains a random sample that is stratified by region, size, and sector.[15] The methodology of the CIS is based on a revised version of the Oslo Manual 2005 (2005) which distinguishes four types of innovation: product; process; marketing; and organisational. Product and process innovations are related with technical innovations. Marketing and organisational innovations are recognised as new forms and belong to the group of non-technical innovations. I use CIS data because it includes information on innovation performance and project termination. Here a multitude of innovation termination indicators can be considered to search for the most parsimonious model that fits the data. These indicators range from hampering factors to innovation activities, external sourcing, research collaboration and, least analysed, organisational changes.

Data for CIS 2010 was gathered in 2011 by means of a voluntary postal survey for the period 2008-2010. The target population included all firms with ten or more employees. In total, 5,151 responses were received in the Czech Republic and 6,851 in Germany. I merge both datasets to total 12,002 observations.

Due to the research design, I restricted the sample to firms that are active in technical innovation (either having introduced product or process innovation) as only those firms actively involved in innovation can experience the termination

[15] The Oslo Manual opted for the subject approach: that is, data is collected at the firm level – including all innovation outputs and activities. This implies that I do not have data about specific innovation projects.

of their innovation process. The resulting dataset has 4,385 observations and is suitable for cross-sectional analyses regarding the dependent and independent variables.

4.4.3 Dependent variable

I use innovation termination (INTER) as the dependent variable in this chapter. Specifically, I construct innovation termination using a binary variable measuring whether the firm had an innovation activity between 2008-2010 that did not result in a product or process innovation because the activity was abandoned or suspended before completion.

4.4.4 Independent variables

a) Firm size

Larger companies have more resources, can start more innovation projects, and also have more opportunities to invest in product innovation. In the models, I use the natural log of employees in 2008 for the variable Ln-SIZE.

b) Research activities

The extent of R&D activities is shown as a very important measure of the innovativeness of individual companies. The values of the variable RESEARCH range from 0 to 2 depending on whether the firm was engaged in in-house R&D activities and/or external R&D activities (performed by other companies, or by public or private research organisations and purchased by the firm) during 2008-2010.

c) Organisational innovation

The CIS 2010 contains three distinctive binary variables for organizational innovation. ORGBUP measures the presence or non-presence of new business practices for organising processes (i.e. lean, quality, and supply chain management) during the period 2008-2010. ORGWKP indicates new methods of organising work responsibilities and decision making (i.e. team work and decentralisation) during the same time period. The ORGEXR variable describes new methods of organising external relations with other firms and institutions.

In the models, I use the variable ORGIN which is a construct of the three abovementioned variables. I merged them so that origin values range from 0 to

3 depending on whether the firm introduced any of the three distinctive variables presented above.

d) Level of internationalisation

The values of the variable MARKET range from 0 to 3 depending on which geographical markets the firm sold goods and/or services in during 2008-2010. Thus, the more markets a firm operates in, the higher the level of its internationalisation. There are three possibilities: national market; other EU, EFTA or EU candidate countries; and all other countries.

e) Marketing activities

The values of the variable MARKETING range from 0 to 4 depending on the introduction of: a) significant changes to the aesthetic design or packaging of a good or service; and/or b) new media or techniques for product promotion; and/or c) new methods for product placement or sales channels, and/or; d) new methods of pricing goods or services during 2008-2010 or 0 otherwise.

4.4.5 Control variables

a) Industry dummy variables

To check for the industry influence for each company I used the Eurostat indicators on high-tech industry and knowledge-intensive services (Eurostat, 2016). I created six groups of industries: low-technology industries; medium low-technology industries; medium high-technology industries; high-technology industries; low knowledge-intensive services; and knowledge-intensive services.

b) Group membership

Membership in an international group of companies is also assigned importance as these companies have better access to resources and direct information from the market. They also have a better capacity to develop new products. In this case, I created a dummy variable. If the company belongs to an international group, the variable value of GROUP is 1 and 0 vice versa.

c) Country dummy variable

I control for the geographical association with either Germany or the Czech Republic. I created a dummy variable CZECH. If the company is based in the Czech Republic, the variable value is 1 and 0 for companies based in Germany.

4.5 RESULTS

Table 12 shows the mean score, standard deviation, minimum and maximum scores, and number of observations of particular variables. I have also included Cronbach's alpha for the independent variables as these are constructs – with satisfactory scores. The statistics show that 20% of the firms in the sample terminated an innovation between 2008-2010. The majority of respondents (58%) are based in Germany compared with Czech Republic (42%). I further observe that a relatively large number of firms are part of an international group (43%). Furthermore, the results indicate that about one-third (33%) of the firms in the sample belong to service industries (25% knowledge-intensive and 8% low-intensive knowledge services) compared to 67% firms belonging to manufacturing industries. Most of the manufacturing firms are part of medium-tech industries (20%) whereas only 9% of respondents are active in high-tech sectors. For correlations between the variables used in this study see Table 13. None of the reported correlations are high.

Table 13: Descriptive statistics

VARIABLES	(1) N	(2) Mean	(3) S.D.	(4) min	(5) max	(6) Cronbach
INTER	4385	0.204	0.403	0	1	
MARKETING	4385	1.253	1.289	0	4	0.65
ORGIN	4385	1.284	1.131	0	3	0.75
MARKET	4385	1.96	1.035	0	3	0.67
RESEARCH	4385	0.970	0.784	0	2	0.55
Ln_SIZE	4385	4.533	1.561	2.30	12.95	
GROUP	4385	0.460	0.498	0	1	
CZECH	4385	0.464	0.498	0	1	
HIGH_TECH	4385	0.088	0.284	0	1	
MEDIUM_HIGH_TECH	4385	0.209	0.406	0	1	
MEDIUM_LOW_TECH	4385	0.159	0.366	0	1	
LOW_TECH	4385	0.187	0.390	0	1	
OTHER	4385	0.041	0.198	0	1	
KNOW_SERV	4385	0.228	0.420	0	1	
LOW_KNOW_SERV	4385	0.084	0.278	0	1	

Table 14: Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
INTER (1)	1.00														
MARKETING (2)	0.09	1.00													
ORGIN (3)	0.13	0.38	1.00												
MARKET (4)	0.14	0.07	0.09	1.00											
RESEARCH (5)	0.18	0.16	0.23	0.05	1.00										
Ln-SIZE (6)	0.16	0.10	0.23	0.26	0.24	1.00									
GROUP (7)	0.12	0.05	0.19	0.18	0.16	0.49	1.00								
CZECH (8)	0.01	-0.08	0.05	-0.03	0.06	0.06	0.10	1.00							
HIGH_TECH (9)	0.04	0.01	0.03	0.16	0.14	-0.03	-0.01	-0.10	1.00						
MEDIUM_HIGH_TECH (10)	0.04	-0.05	0.01	0.26	0.17	0.17	0.13	0.01	-0.16	1.00					
MEDIUM_LOW_TECH (11)	0.01	-0.05	-0.02	0.12	0.04	0.09	0.03	0.06	-0.13	-0.22	1.00				
LOW_TECH (12)	-0.01	0.06	-0.08	-0.01	-0.12	-0.06	-0.10	0.03	-0.15	-0.24	-0.21	1.00			
OTHER (13)	-0.01	-0.02	0.00	-0.17	-0.10	0.01	0.01	0.07	-0.06	-0.10	-0.09	-0.10	1.00		
KNOW_SERV (14)	-0.01	0.04	0.05	-0.24	-0.03	-0.17	-0.05	-0.07	-0.16	-0.27	-0.23	-0.26	-0.11	1.00	
LOW_KNOW_SERV (15)	-0.05	0.01	0.00	-0.14	-0.16	0.00	0.00	0.00	-0.09	-0.15	-0.13	-0.14	-0.06	-0.16	1.00

I use logistic regressions in this analysis as the dependent variable (innovation termination 'INTER') is binary. I ran several models in a hierarchical manner starting only with control variables and gradually including several independent variables one by one. To check for multicollinearity I conducted a post estimation variance-inflation factor test that excluded collinearity among the independent variables (Table 14). The results of the models are shown in Table 15.

Table 15: Post-estimation VIF test

Variable	**VIF**	**1/VIF**
Ln_SIZE	11.58	0.0863
MARKET	6.59	0.1518
RESEARCH	3.19	0.3138
ORGIN	2.97	0.3371
MEDIUM_HIGH_TECH	2.64	0.3792
GROUP	2.48	0.4039
MARKETING	2.39	0.4181
LOW_TECH	2.23	0.4481
MEDIUM_LOW_TECH	2.20	0.4543
KNOW_SERV	2.12	0.4721
CZECH	1.99	0.5019
LOW_KNOW_SERV	1.54	0.6479
OTHER	1.28	0.7787
Mean	3.32	

Table 16: Logistic regressions on innovation project termination

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7
Ln_SIZE		0.217***					0.138***
		(0.0279)					(0.0292)
MARKETING			0.177***				0.0738**
			(0.0289)				(0.0326)
ORGIN				0.250***			0.118***
				(0.0344)			(0.0390)
MARKET					0.294***		0.171***
					(0.0362)		(0.0405)
RESEARCH						0.541***	0.393***
						(0.0530)	(0.0565)
CZECH	-0.00490	-0.000238	0.0402	-0.0357	0.0155	-0.0515	-0.022
	(0.0772)	(0.0785)	(0.0779)	(0.0779)	(0.0654)	(0.0783)	(0.0807)
GROUP	0.634***	0.308***	0.601***	0.530***	0.548***	0.529***	0.242***
	(0.0777)	(0.0894)	(0.0781)	(0.0793)	(0.0705)	(0.0791)	(0.0909)
MEDIUM_HIGH_TECH	-0.181	-0.326**	-0.155	-0.139	-0.167	-0.111	-0.198
	(0.142)	(0.145)	(0.143)	(0.143)	(0.142)	(0.144)	(0.147)
MEDIUM_LOW_TECH	-0.317**	-0.426***	-0.291*	-0.251	-0.253	-0.165	-0.207
	(0.151)	(0.154)	(0.152)	(0.153)	(0.152)	(0.154)	(0.157)
LOW_TECH	-0.321**	-0.367**	-0.367**	-0.243	-0.171	-0.0368	-0.052
	(0.148)	(0.150)	(0.149)	(0.150)	(0.149)	(0.152)	(0.157)
OTHER	-0.449**	-0.612***	-0.447**	-0.416*	0.048	-0.0392	-0.017
	(0.226)	(0.235)	(0.227)	(0.228)	(0.231)	(0.233)	(0.248)
KNOW_SERV	-0.396***	-0.351**	-0.420***	-0.397***	-0.115	-0.174	-0.052
	(0.143)	(0.145)	(0.144)	(0.144)	(0.143)	(0.146)	(0.152)
LOW_KNOW_SERV	-0.837***	-0.941***	-0.862***	-0.803***	-0.554***	-0.438**	-0.451**
	(0.194)	(0.199)	(0.195)	(0.195)	(0.196)	(0.200)	(0.207)
Constant	-1.365***	-2.162***	-1.602***	-1.684***	-2.084***	-2.062***	-3.036***

	(0.125)	(0.166)	(0.132)	(0.135)	(0.161)	(0.146)	(0.203)
Observations	4,385	4,385	4,385	4,385	4,385	4,385	4,385
ll	-2169	-2099	-2150	-2142	-2146	-2115	-2039
chi2	97.89	158.2	134.9	151.3	142.2	205.8	277.6
r2_p	0.0221	0.0363	0.0304	0.0341	0.0321	0.0464	0.0637
p	0	0	0	0	0	0	0

Note: 'High-tech' is the default category. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.10.

Model 1 consists only of control variables followed by models 2 – 6 (each with one independent variable). Model 7 is the full model that includes all the variables. The results confirm hypotheses 1, 2, 3, and 4 and indicate a significant positive influence for company size, organizational innovation, and level of internationalisation on innovation termination. The influence of the variable 'research activities' supports the view that the more the firm is involved in research activities, the higher the probability of innovation project termination. The level of internationalisation also positively associates with the likelihood of terminating an innovation activity.

Surprisingly, there is no support for hypothesis 5. I find the opposite to be true; marketing innovation is significantly and positively associated with innovation termination.

There are also some interesting results regarding the control variables. Group membership is a statistically significant predictor of innovation termination in all the models. However, there is no statistically significant difference between firms based in the Czech Republic or Germany regarding their propensity to terminate innovation. Finally, the full model (model 7), shows that only low tech firms are significantly less prone to terminate innovation activities compared to high tech firms.

4.5.1 Robustness checks

I conducted a set of robustness checks to mitigate potential endogeneity and selection bias problems. Firstly, I divide the dataset into two sub-samples – respondents based in the Czech Republic and in Germany – to check whether there are any significant differences between these countries. I use the same models for the whole sample. Starting with marketing innovation there is no significant influence on innovation termination in the German sub-sample (with the coefficient -0.0391), but that it is a very strong predictor in the Czech data (0.168***). On the other hand, organizational innovation (0.173***) and the level of internationalisation (0.226***) significantly influence the probability of discontinuing innovation activity in the German sub-sample – but these variables have no significant impact in the Czech sub-sample (0.0531 for organizational innovation and 0.106 for the level of internalisation). The only predictor having the same significant influence on the dependent variable is

internal and external R&D (0.515*** for Czech and 0.222*** for the German sub-sample). The analysis shows that the results in the combined sample are indeed driven either by Czech or German respondents.

Secondly, I test the robustness of the results regarding the nature of R&D activity. I differentiate between internal and external R&D activities. Differences are possible as, for example, external R&D (that is R&D performed by other enterprises, or by public or private research organisations, and purchased by the focal firm) may be more prone to discontinuation due to the not-invented-here syndrome. Firms may also lose control over the process and outcomes of research activity performed outside their boundaries. Nevertheless, the results remain stable: both internal and external R&D have the same significant effect (0.709*** respectively 0.340***), and the coefficients of other variables are almost identical, so I can argue that there is no added value to distinguish between the two types of R&D activity in the models.

Thirdly, I checked the robustness of the results – including an additional control for innovation cooperation with other enterprises or non-commercial institutions (excluding pure contracting with no active cooperation). Controlling for cooperation on innovation activities is important since it indicates that a firm is opening its boundaries and reaching out to the vast pool of external knowledge, talents, and products that may have a significant impact (both negative and positive) on its ability to innovate – depending on the right sequence of implementation steps and the firm's attention span. Again, innovation cooperation has no significant effect on the dependent variable (coefficient 0.00751) while other values almost remain the same (meaning that the results are not confounded by unobserved effects of innovation cooperation).

Finally, I control for the degree of newness of the product and/or process innovation introduced by the firm during 2008-2010. I possess information about whether an innovative product/process is either new-to-the-market or new-to-the-firm. Firms involved in radical innovation activities (meaning introducing products/processes that are completely new to the market) may be more prone to terminate innovation activities (as these are riskier) than incremental innovation activities (which are more closely aligned with market needs). Nonetheless, this is not the case in the dataset as firms introducing radically new

innovation activities are not significantly more prone to terminate projects (coefficient 0.0947) than firms introducing only incremental innovations.

4.6 DISCUSSION AND CONCLUSION

This chapter examines the factors associated with innovation termination. I distinguish among five factors assumed to play a role in either decreasing (marketing innovation) or increasing (firm size, research activities, organizational innovation, level of internationalisation) the probability of innovation termination. In exploring these issues, the chapter provides empirical evidence of the firm-level factors influencing innovation termination.

The main findings contribute to the innovation process management literature in several ways. Firstly, I offer empirical evidence on the relationship between various firm-level factors and the propensity to abandon an innovative activity. Secondly, I'm not constrained by any specific industry, and show results for manufacturing and service sectors.

I find that larger firms tend to terminate innovation activities more frequently than their smaller counterparts. Large firms have the advantage that they can rely on formalised evaluation methods for innovation projects, which reduces the chance of an escalation of commitment to projects with poor prospects (Benner & Tushman, 2002). The factors reducing the likelihood of escalation (Sleesman et al, 2012) involve among others the salience of opportunity cost information and information acquisition. These factors again are more likely to be found at larger companies as they have capabilities for relevant information collecting. Small firms are more selective and only start innovation endeavours when there is a good chance that they will become a commercial success. Secondly, firms that are more systematically involved in (internal and external) R&D activities have a higher propensity to abandon innovation projects. Companies conducting R&D systematically are more formalised, and therefore the termination of projects is decided on objective criteria.

Thirdly, firms that develop new business practices (e.g. increasing agility, quality and supply chain management) and new methods of organising work responsibilities, decision making, and organising relationships with other firms and institutions, also are inclined to terminate more non-promising innovation

activities than their counterparts who are not developing such organisational agility. I argue that large companies executing various research activities simultaneously are more prone to abandoning innovation projects than their smaller counterparts with more limited R&D activities. That does not necessarily mean that larger firms are less innovative. Rather it indicates that larger companies with greater R&D budgets have a more formalised and objective screening process leading to a higher attrition rate during the selection process. Due to more routinised innovation management (Christiansen & Varnes, 2009), these large and resource-intense companies also possess more effective screening mechanisms to detect potentially successful from unsuccessful innovations (Schultz et al., 2013). These formal control mechanisms include the project management (PM) and stage-and-gate-type systems (SGS) that are needed to create a structure for managing innovation and coordinating between different functional groups within a firm (Schultz et al., 2013, Brown & Eisenhardt, 1995). These controls provide employees engaged in innovation endeavours with an overview of the procedure and sequence for their work, reducing ambiguity about required activities, timelines, and goals (Tatikonda & Montoya-Weiss, 2001). Hence, formalised controls reduce uncertainty and error by terminating unfeasible innovative activities early on. These controls can save considerable money and hence, increase overall performance. Smaller and resource-constrained firms are forced to make tough decisions about a handful of 'safe bets' leading to a lower rate of project terminations. Thus, they hold on to certain innovative activities longer and probably even commercialise innovations that should not have reached market in the first place. Firms that are agile and flexible are more likely to terminate innovation projects because they constantly recombine existing resources and evolve in new directions. Such changes in direction open different opportunities and create input for repeatable, new innovation endeavours – but also lead to a higher attrition rate where only few 'winners' successfully emerge from the funnel.

Fourthly, I find that firms that internationalise have to compete in different markets with strong competitors – but they also leverage innovations across various markets and so earn a greater return on innovative products. Firms that operate on a highly international level are also more likely to compete

on the frontier of technology and hence they may take more risks across different markets – and this may lead to more innovation activity being terminated. Moreover, international companies are likely to develop objective procedures regulating how to terminate innovative endeavours, thus reducing the risk of commitment escalation by individual managers.

Finally, I find no evidence for the hypothesis that marketing innovation would lead to a reduction in terminating innovation projects. I argued that stronger marketing capabilities would lead to lower risks for innovation termination. The opposite seems true. I explain this surprising result by the fact that firms developing strong marketing capabilities (such as new product promotion techniques, product positioning methods and pricing methods) have additional tools to reject unpromising projects. These additional tools are in addition to the usual tools for objectively estimating the technology performance of a project. These additional tools release more market information and the enhanced screening of the market potential of a new innovation leads to a more formalised scrutiny of progress – and hence earlier termination when market expectations are unmet. Innovation process research has usually treated the innovation process as a linear sequence of functional activities (Saren, 1984, Rothwell, 1994). A key problem with innovation is that firms need to make sense of a complex, uncertain, and highly risky environment.

The results have some relevant managerial implications. The research contributes to a better understanding of barriers to innovation by improving the ability of firms to recognise sources of failure. Hence, they can continue to eliminate firm-level obstacles to innovative activity, and so maximise innovative efforts. All the factors examined in this chapter positively contribute to innovation termination: increasing the incidence of project termination can be perceived as harmful to overall innovation performance by firms, but terminating less promising projects helps firms to fully exploit their innovation potential in the long-run. Establishing effective and flexible screening mechanisms to detect successful from potentially unsuccessful innovations can save a considerable amount of money and hence, increase overall performance.

As organisational agility is consistently associated with terminating an innovative endeavour, independently of industry sector and innovation quality,

there is a need to find the right organisational setting for innovation. Firms must continuously search for changes in procedures and business practices to respond to market demands and develop commercially viable products. The results contribute to the debate about whether innovation can be managed despite its enormously complexity and uncertainty. The results show that in addition to problems in applying and adapting basic knowledge to new products and processes, I find additional firm-level factors contributing to that uncertainty. Yet despite these potential barriers to success, it is possible to identify some underlying patterns of success.

In this chapter I argue that the termination of innovation projects is a laudable management practice and an effective detection of such failures is necessary to avoid waste of time and high costs in continuing projects. Even if an innovation fails, responding to and managing such failure appears to be a valuable learning opportunity – and this improves the chances of successful future innovation. Thus learning from innovation termination creates the foundation for efficiently and successfully managing innovation. Particularly in cases of low (R&D) productivity and high late-stage attrition rates, so called 'quick-kill' strategies promote fast learning curves as they seek to bring forward decisions to terminate projects to an earlier point in the process (Peck et al., 2015). Hence, based on these findings, I analyse factors within firms that make a successful innovation more likely despite high levels of uncertainty. As the innovation process involves dealing with uncertainty it should provide enough flexibility to help monitor and adapt projects over time – but also enough rigour to justify termination of projects when the unknown becomes known. Knowledge is gathered at an increasing cost – but uncertainty decreases and so becomes calculated risk.

4.6.1 Limitations and further research

While this study provides important contributions and shows that firm size, research activities, level of internationalisation, as well as organizational innovation, can be important factors for innovation project termination, some questions remain unanswered – providing exciting opportunities for further research. A problem that arises is the capacity of managers to maintain and control different innovation projects at the same time Ocasio, 1997). Hence, it might be more difficult to handle projects of different types (e.g., marketing

innovation and product innovation projects) than projects of one type (e.g., process innovation). Therefore, it would be interesting to contribute to the innovation process management literature by examining whether the (coordination and transaction cost) effort increases when a firm engages in interrelated innovation projects compared to unrelated projects. Thus, future research could investigate firm portfolios regarding different types of innovation projects.

Furthermore, the findings do not account for the frequency, nor the number of a firm's innovation termination experiences. Nonetheless, this indicates a potential for organisational learning triggered by the negative experience and leaves room for firms to design an organisational culture that strongly support employees learning from the termination of unpromising projects, rather than considering each project termination as a failure. This opens interesting avenues for further research using organisational learning theory (e.g., Argote et al., 1990, Chiesa & Frattini, 2011, Lampel et al., 2009) to analyse the development of innovation project management capabilities within firms to reduce the likelihood of further unwanted innovation project terminations. Therefore, it would be interesting and highly rewarding for theory building on the creation of innovation project management capability by firms to investigate the drivers and reasons for innovation project termination. In light of the organisational learning and dynamic capabilities literature (Teece et al., 1997, Winter, 2003, Eisenhardt, & Martin, 2000), further research should aim to learn from terminations (and their intrinsically dynamic nature) and whether this increases or decreases the number of future terminations and hence has a positive impact on overall innovation performance. Moreover, I encourage future research to incorporate control mechanisms such as PM or SGS in their models – and include the degree of innovativeness as a moderating factor and show to what extent control mechanisms influence innovation termination.

Furthermore, I encourage future research to take a multi-level perspective by studying combined project and firm-level factors of innovation project termination to gain a more integral understanding. Finally, I suggest extending the findings by specifically differentiating between innovation projects building on core/non-core technologies and the impact on innovation project termination. Innovation

projects building on core-technologies may be less prone to termination than projects that are more radical and/or based on non-core technologies.

The empirical evidence presented in this chapter should be considered carefully as the data collected in innovation surveys is qualitative, subjective, censored, and cross-sectional (Mairesse & Mohnen, 2010). In this vein, I can neither account for the number of projects the firms in the sample are simultaneously working on, nor the absolute number of projects terminated. I also do not know at which stage of the process the projects were terminated. I cannot link the effective termination of innovation projects to a firm's innovation performance as I do not have the data. There should also be a time lag between independent and dependent variables to induce causality. These limitations represent a potential for interesting future research questions. Another limitation of this study lies in the fact that the survey is subjective and based on assertions by individual managers on their company's termination behaviour. Although the reliability and validity of the survey has been established, some questions may remain slightly subjective and rely on the perception of the respondent and his/her involvement in innovation activities. These limitations offer a wide and valuable spectrum of potential future research questions and increasingly relevant contributions in the realm of innovation process management and new product development.

5 THE MODERATING EFFECT OF ORGANIZATIONAL INNOVATION AND ABSORPTIVE CAPACITY ON THE OPEN INNOVATION AND INNOVATIVE PERFORMANCE RELATIONSHIP

5.1 INTRODUCTION

Which firm-level factors drive the success of firms' innovation efforts has been extensively investigated. Firm size, age, experience with R&D and innovation projects, the existence of an R&D department, and interfirm collaboration are deemed the most important factors leading to successful innovation performance. As a result of increasing complexity and the multi-disciplinarity of research and development (R&D) and innovation efforts, firms seek to access complementary assets and knowledge outside their boundaries (Miotti & Sachwald, 2003). This aligns with a trend towards more openness where companies have shifted from closed innovation strategies and processes, increasingly relying on external knowledge (Laursen & Salter, 2006) and R&D collaborations (Cassiman & Veugelers, 2002) to develop new products, services, and processes.

Open Innovation (OI) has received huge scholarly attention (Bogers et al., 2017). It describes an umbrella framework that encompasses, connects and integrates the processes of acquiring external knowledge and exploiting internal knowledge externally (Huizingh, 2011). Since OI is mainly a firm-level construct, it provides deeper understanding of how firms use inflows of knowledge to accelerate internal innovation (inbound OI) and outflows of knowledge (outbound OI) to expand the markets for external use of innovation (Chesbrough, 2006). Recent OI literature touches upon a variety of related innovation phenomena and perspectives that relate to different practices of OI, different OI partner types (customers, suppliers, etc.) and how firms can successfully implement OI activities in their core strategies and processes (Ades et al., 2013). Additionally, previous open innovation literature has extensively shown the positive effect of firms' OI activities on their innovative performance (Bogers et al., 2017). While previous literature delivers unique insights into the peculiarities of distributed innovation processes, the simultaneous use of OI with other sources for successful innovation performance has been underexplored.

Hence, OI has always been considered as a single source of a firm's innovation strength. In particular, most studies have examined the impact of OI on innovation performance very isolated (Dahlander & Gann, 2010, Duarte & Sarkar, 2011, Greco et al., 2016). Particularly, research has not confronted firms' OI activities with other potential sources of innovation performance. Other simultaneous sources of successful innovation were neglected by previous OI research. Nonetheless, managerial practice shows that innovation within firms can be done in different ways. In addition to OI, firms can also choose to do closed innovation, where all product innovation (R&D, prototype development, and manufacturing) is done in-house innovation or engage in organizational innovations. In line with the dynamic capabilities view, firms should then be able to "look around the corners" and being able to flexible recognize new trends to elaborate on. Hence, engaging in agile and dynamic organizational innovation processes, firms can also boost their innovative performance (Tidd et al., 2005). What happens if companies have the choice between different strategies? This is of particular importance since organizational resources are finite and firms have to allocate resources over various activities (Cyert & March, 1963, Levinthal & March, 1993), such as balancing them between "business as usual" and innovation activities (O'Reilly & Tushman, 2004, Raisch & Birkinshaw, 2008), marketing, R&D and operations (Krasnikov & Jayachandran, 2008), or between exploration and exploitation (Lavie et al., 2010, March, 1991). Although the literature broadly recognizes the need to balance resources (Raisch & Birkinshaw, 2008), previous innovation research has not yet delivered many examples of these complementarities/trade-offs/simultaneous sources of innovation performance. As a result, firms might have to specialize on certain activities as resources are limited and they cannot be equally good and successful at everything.

In this chapter, I focus on three alternative sources of innovation performance a firm can choose from: closed innovation, open innovation and organizational innovation. Therefore, in this chapter I study the moderating effects of organizational innovation and absorptive capacity on the relationship between open innovation and innovation performance. I conceive of openness as interfirm

exchanges with different partners directed towards innovation.[16] The research question I will answer in this chapter is: "*What impact do organizational innovation and absorptive capacity have on the relationship between open innovation practices and the innovation performance of a firm*?"

In this chapter, I aim to accomplish two objectives: (1) shed light onto whether organizational innovation and absorptive capacity augment or weaken the positive effect of open innovation on innovation performance and hence (2) whether either of the two variables enhances the positive effects of OI practices on innovation performance. For this study, I use the German and Czech Community Innovation Survey 2010 (CIS 2010), resulting in 10.721 firm observations, to understand their innovation behaviour and, specifically, the relationship between innovation cooperation, innovation performance, organizational innovation, and absorptive capacity. As a result of this research, firms can apply best practices concerning if and how to adapt their internal processes when entering into open innovation. I find that there is a pronounced effect of open innovation activities on innovation performance measured by percentage of total turnover in 2010 from innovative products. Interestingly, the findings show that absorptive capacity has its own positive effect on innovation performance, but it levels off the effect of open innovation up to a level that at the highest level of openness absorptive capacity doesn't have any impact on innovation performance. Absorptive capacity is thus a substitute for open innovation in improving the innovativeness of firms. I find similar results for organizational innovation which is also a substitute for open innovation in improving the innovativeness of firms. This research contributes to the literature studying open innovation by providing boundary conditions for the open innovation-performance relationship. Moreover, I study the boundary conditions of open innovation through coupling it with organizational innovation processes (Teece, 2007; Teece, 2009) and absorptive capacity (Cohen & Levinthal, 1990). In doing so, I raise the awareness of researchers and practitioners about adapting or maintaining internal processes and methods of organizing external relations as an additional reinforcing source of innovation project performance.

[16] I acknowledge that open innovation according to Chesbrough (2006) also includes licensing and other modes of firm interaction. However, I focus on innovation search, cooperation, and external R&D.

The chapter is organized as follows: Section 5.2 reviews the theoretical literature on the subject and Section 5.3 presents the hypotheses for empirical testing; Section 5.4 describes the data, the econometric method I use, and the measurement of main variables; Section 5.5 presents the results and Section 5.6 concludes with a discussion of main findings and provides some implications for further research.

5.2 LITERATURE REVIEW

5.2.1 Open innovation and innovation performance

Open innovation has aroused enormous interest and has become an en vogue topic for both research and management. In recent decades, innovative firms have shifted from the 'closed innovation' paradigm, in which companies rely on internal capabilities, towards the 'open innovation' model (Chesbrough, 2003), using a wide range of inter-organizational ties and sources (Laursen & Salter, 2006). Companies may benefit from outside partners when developing and commercializing inventions (Chesbrough, 2003; Dahlander & Gann, 2010).

As a result, studies usually find a positive relationship between open innovation practices and innovation performance (e.g. Belderbos et al., 2004; Hagedoorn, 2002; Sampson, 2007; Stuart, 2000; Laursen & Salter, 2006). In a meta-analytic study Wijk et al. (2008) discovered a positive relationship between inter-organizational knowledge transfer and company performance (Lane et al., 2001; Szulanski, 1996), as well as innovativeness (Jansen et al., 2005; Powell et al., 1996). Another stream of literature addresses the advantages of open innovation practices in corporate venturing (Vanhaverbeke et al., 2008; Vrande, 2009b). Nonetheless, the additional drawbacks, tensions, and contingencies of openness are yet to be examined (Dahlander & Gann, 2010; Knudsen & Mortensen, 2011). Some initial contributions show that open innovation is associated with the imitation of intellectual property (Veer et al., 2016).

In general, prior research associates the essential positive returns of larger firms with an open innovation strategy, as well as with the breadth and depth of external information sources (Chen et al., 2011; Katila & Ahuja, 2002; Leiponen & Helfat, 2010; Tomlinson, 2010). Furthermore, Lee et al. (2010) and Vrande et

al. (2009a) prove open innovation to be beneficial for small and medium-sized enterprises (SMEs).[17]

5.2.2 Organizational innovation and dynamic capabilities

Organizational innovation has often been discussed in the context of dynamic capabilities (Teece et al., 1997; Bessant et al., 2012; Eisenhardt & Martin, 2000). Firms in today's ever more complex and rapidly-changing business world need these capabilities in order to be able to react fast and flexibly to any changes caused internally or by the environment along with the management capability to effectively coordinate and redeploy internal and external competences (Teece et al., 1997). In particular, internal, structural changes such as the introduction of new processes or adapting internal and external organizational skills, resources, and functional competences toward a changing environment or the reallocation of people and resources to different departments require a lot of patience and efforts and firms will incur transaction costs. Zollo & Winter (2002) argues that dynamic capabilities evolve as a product of learning through (1) the accumulation of experience, (2) the articulation of knowledge, and (3) knowledge codification processes. Hence, being able to learn from partnering and knowledge acquisition experiences can lead to the evolution of dynamic capabilities. An understanding of learning as a dynamic capability is important mainly because of its focus on routines. Organizational routines refer to repeated patterns of behaviour bound by rules and norms (Cyert & March, 1963; Nelson & Winter, 1982). Although routines have long been thought of as a possible cause of organizational inertia (Hannan & Freeman, 1984), Feldman (2000) proposes that *"there is an internal dynamic to routines that can promote continuous change" through "participants' reflections on and reactions to various outcomes of previous iterations of the routine"* (p. 611).

5.2.3 Absorptive capacity

In today's world, which is largely driven by knowledge and technology-intensive businesses, the importance of learning from external knowledge is

[17] I am aware of the fact that the umbrella term "open innovation" subsumes more aspects (e.g. licensing, eco-systems, co-creation, etc.) than just R&D cooperation. However, R&D cooperation has been a relevant and frequently used indicator to measure firms' openness activities in the literature (Laursen & Salter, 2014; Mention, 2011; Teirlinck & Spithoven 2013).

growing. Previous studies have performed intensive analyses of the concept of absorptive capacity in the context of effective learning from external knowledge. Cohen & Levinthal (1990) developed the concept of absorptive capacity to address the capability to learn from external knowledge that is new to the firm. The concept builds strongly on prior related knowledge that tends to develop cumulatively, which is formed by the organizational history and industry relevance in terms of complementarity and diversity. Absorptive capacity – often described as a dynamic capability (Zahra & George, 2002) – has initially been defined as the ability of a firm to *"recognize the value of new information, assimilate it, and apply it to commercial ends"* (Cohen & Levinthal, 1990, p. 128). Lane et al. (2006) presents a definition that allows an even deeper understanding of absorptive capacity:

"Absorptive capacity is a firm's ability to utilize externally held knowledge through three sequential processes: (1) recognizing and understanding potentially valuable new knowledge outside the firm through exploratory learning, (2) assimilating valuable new knowledge through transformative learning, and (3) using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning." (p. 856).

Absorptive capacity (AC) aims at improving innovation and performance outcomes. The refined model of Todorova & Durisin (2007) illustrates the core aspects of absorptive capacity. First, these consist of knowledge sources, prior knowledge, and the recognition of value. Recognizing value addresses the cognitive ability of organizations to recognize and value external information new to the firm. This is followed by the acquisition of external knowledge, which deals with the intensity, speed, direction, and effort to acquire new knowledge (Zahra & George, 2002). The next step covers the integration of the knowledge in the firm and splits into either assimilation or transformation of the knowledge. Finally, the exploitation of knowledge refers to "a firm's ability to harvest and incorporate knowledge into its operations" (Zahra & George, 2002, p. 190). This exploitation results in the continuous development of new products, processes, structures, knowledge, or organizational structures.

The research and development (R&D) departments of large or established firms are an important driver of the development of absorptive capacity and the

absorption of external knowledge (Argote, 2013). Most previous studies argue that absorptive capacity is a capability that aims at knowledge creation and usage (Zahra & George, 2002) to achieve and sustain a competitive advantage in terms of flexibility, innovation, and performance.

5.3 HYPOTHESES

5.3.1 The Effect of Open Innovation Practices on Innovation Performance

Firms apply different OI practices to develop new products/services (Chesbrough, 2003; Chesbrough, 2006; Laursen & Salter, 2006) as they can gain considerable cost and time advantages by engaging in innovation collaboration. Firms collaborate to extend their technological competences (Lee et al., 2010), but at the same time they need to offer something valuable (e.g. technological assets) in exchange to the partner (Narula, 2004). Firms also need to be able to translate research insights from collaboration into their own internal processes and structures to develop useful innovations that can be integrated into new products or services. When they cooperate in innovation, they not only rely on close and obvious partners such as suppliers and customers but also engage in partnerships with universities, research centres, governmental institutions, and even competitors (Howells, 1999; Laursen & Salter, 2006; Laursen & Salter, 2004; Lazzarotti et al., 2011). Firms collaborating with different partners can benefit from spillover effects and develop dynamic capabilities and new know-how from previous partnering projects. They can then reapply lessons learnt and best practices for future projects.

Additionally, external R&D is an important driver in the realization of firms' growth objectives (Chesbrough, 2003; Vrande, 2009b). External R&D is often initiated when a firm lacks certain internal resources or is not able to perform expensive in-house R&D (Narula, 2004). However, in the case of external R&D, innovation performance depends greatly on the quality of the external R&D, as well as the complementarity with internal know-how. If external know-how can be implemented effectively in internal new product or process development practices, revenues from successful product/service introductions can be realized (Spithoven et al., 2013). In particular, access to unique technologies through

external R&D may help firms to achieve better innovation performance regarding the introduction of new products or revenue generation from new products/services.

In sum, opening up firm boundaries refers to the process of introducing new forms of external relationships with other companies or institutions (e.g. alliances, customer relationships, supplier integration). Thus it refers to a change in how a firm navigates the external environment and reaches out to external partners. As stated above, a firm usually does not possess all the necessary know-how in-house to successfully develop and/or commercialize new products, services, or processes. Hence, a firm needs to regularly obtain new input and ideas from outside to enhance its own capabilities and to be able to fully exploit the potential of, and manage, technological innovation activities.

On the basis of the arguments presented above, I propose the following:

H1: Open Innovation is positively associated with innovation performance.

5.3.2 The moderating role of organizational innovation and absorptive capacity

Organizational innovation

Realizing knowledge spillovers from open innovation activities has often been discussed in the context of organizational innovation (Teece et al., 1997; Bessant et al., 2012; Eisenhardt & Martin, 2000). On the one hand, routines have the potential to make innovation processes much more systematic and efficient and thus bring added value to the organization. At the same time, once properly implemented, the new routines derived from learning from failure, for example, are thus one of the drivers of continuous organizational innovation (e.g. Chesbrough, 2006; Chesbrough, 2010; Huizingh, 2011; Chiaroni et al., 2011; Hage, 1999; Mortara & Minshall, 2011). Organizational innovation is important for the economic sustainability of firms. Thus, a firm's technology base is necessary but is not the only precondition for market success. There is a need for new capabilities and organizational arrangements within companies so as to be able to fully exploit the potential of, and manage, technological innovation activities. The ability to renew itself means that an organization is able to evolve constantly because of a proactive search for, and utilization of, new knowledge and innovations in order to recombine its core competencies and/or make changes in

its product market domain (Floyd & Woolridge, 2000). In the sample, change refers to the introduction of new methods used to organize business processes such as quality management, supply chain management, lean production, and knowledge management, as well as the introduction of new forms of work organization such as decentralization, job rotation, teamwork, or the restructuring of units/departments. Thus change is often a necessary requirement for innovation but at the same time it can also be a barrier to successful innovation.

In general change never comes easily, as the strong and enduring inertial forces exerted by ossified competencies are difficult to overcome. The organization's structures, procedures, and relationships continue to reinforce prior patterns of behaviour and thus resist the development of new ones. Consequently, internal organizational innovations sometimes result in upheavals and dissatisfaction, and possibly even in resignations and dismissals among employees, also known as "not-invented-here syndrome". Therefore, employees might have to concentrate on the changes introduced first or be allocated to a new project, team, or department. Internal changes might also require some resources that cannot be spent on R&D or innovation projects. As a result of organizational innovations, firms' priorities may alter or need to be adapted to current needs and they may thus abandon current R&D/innovation projects in the short run. Any change within the organizational arrangements of a firm makes it vulnerable and may have a short-term negative effect on its innovation performance. Previous research has shown that the lack of internal commitment might serve as a constraining factor for open innovation practices (Chesbrough, 2006). Hence, if a company internally resists or avoids change this will have a negative influence on the success of open innovation activities. In line with this argumentation I come to the following hypothesis:

H2: Internal organizational innovation has a positive moderating effect on the relationship between open innovation and innovation performance.

Absorptive capacity

Firms differ in their ability to assimilate and replicate new knowledge gained from external sources. Benefiting from external partners is closely related to how well a firm is organized internally to capture the external knowledge (Enkel et al., 2011; Chiaroni et al., 2011). Thus, internal processes need to be aligned to the

external environment to enable successful absorption of knowledge from partners (Cohen & Levinthal, 1990; Laursen & Salter, 2014).

Moreover, firms that possess relevant prior knowledge are likely to have more insights and combinatory capabilities concerning new technology that can produce innovative products, processes, and services. Companies with a high level of absorptive capacity are likely to extract and combine new knowledge from other actors to help their innovative activities (Tsai, 2001). As Cohen & Levinthal (1990) suggests, the ability to utilize external knowledge is often a byproduct of R&D investment. R&D investment and knowledge accumulation are a necessary condition for the creation of absorptive capacity. Higher R&D investments are associated with an increase in the total innovative output. Firms with a high level of absorptive capacity invest more in their own R&D and have the ability to produce more innovations. As a result, absorptive capacity also involves the ability to apply new external knowledge to commercial ends and, thus, create the opportunity for profits. In addition, a firm with a high level of absorptive capacity is likely to apply new knowledge to improve its turnover on new products/services.

The extant research often argues that companies need to conduct their own R&D to increase their absorptive capacity (Cohen & Levinthal, 1990) to benefit from cooperation by realizing incoming spillovers and targeting external knowledge resources more systematically (Cassiman & Veugelers, 2002; Kamien & Zang, 2000; Kaiser, 2002). Moreover, empirical studies demonstrate that firms' absorptive capacity depends on their own R&D intensity (R&D expenditures/turnover) (Cohen & Levinthal, 1990). R&D investments signify that the firm is able to develop its own knowledge base and internal capabilities.

Firms that have personnel with the required scientific background to understand, absorb, and exploit the scientific discoveries and technologies that are developed at universities or research labs or inside large companies have greater 'absorptive capacity' (Cohen & Levinthal, 1990). Hence, firms that possess the required human resources (highly skilled knowledge workers) and R&D infrastructure are better able to collaborate effectively with different types of innovative partners. Hence, the greater a company's absorptive capacity, the more likely it is that the firm is able to recognize what it does not know yet. Moreover, if a company uses external R&D, it also has to rely on a sufficiently

developed internal R&D capability to absorb this knowledge (Cassiman & Veugelers, 2006). Thus, the firm's benefits from open innovation practices will increase with growing absorptive capacity as the firm realizes incoming spillovers and can target external knowledge resources more systematically. I formulate the following hypothesis:

H3: Absorptive capacity has a positive moderating effect on the relationship between open innovation and innovation performance.

Figure 8 below provides a summary of hypothesized relationships.

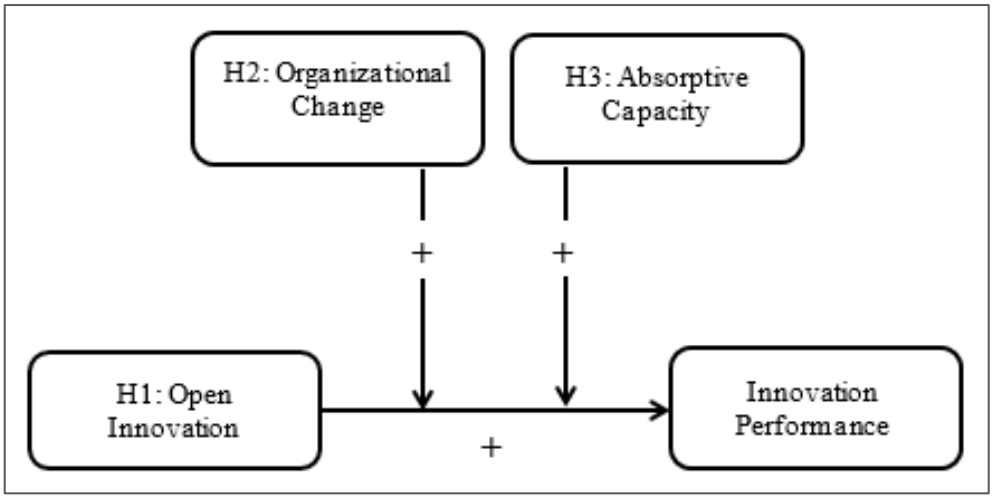


Figure 8: Conceptual Model.

5.4 METHOD

5.4.1 Data

The Community Innovation Survey (CIS) is now conducted in all European Union (EU) member states on the basis of the Oslo Manual recommendations (OECD, 1992; OECD, 1996; OECD, 2005), sometimes even at a regional level. Innovation surveys exist under different acronyms in many other OECD countries, but also in emerging economies, transition countries, and developing countries. By and large the surveys have the same structure and the same questions regarding innovation, but there are some differences across countries—even in the CIS—regarding the content, formulation, and ordering of the questions (Mairesse & Mohnen, 2010). As a result, the CIS data has frequently been used

but mainly includes information from one wave in one country and the CIS data is therefore cross-sectional in nature. As discussed above, the CIS data has been exploited extensively, in all sorts of ways, which is why researchers now recommend using the CIS data by combining either different waves or different countries (Mairesse & Mohnen, 2010). Only a few studies have started to incorporate more than one country into their analysis, although this data increases the reliability and validity of the results (Evangelista et al., 2001). A few notable studies include the contributions by Harrison et al. (2014), Murovec & Prodan (2009), Horbach et al. (2013), Freitas et al. (2011), and Therrien & Mohnen (2003).

Additionally, Leoncini (2016) performs a set of empirical estimates on the effect of innovation failure on innovative activity on the basis of a large dataset of innovative firms from sixteen countries drawn from the 2008 Community Innovation Survey.

5.4.2 Sample

For this study, I use the German and Czech Community Innovation Survey 2010 (CIS 2010), which includes the core Eurostat CIS and additional topics for firms in Germany. The study is conducted every year and contains a random sample that is stratified by region, size, and sector.[18] The methodology of the CIS is based on a revised version of the Oslo Manual 2005 (OECD, 2005) which distinguishes four types of innovation: product, process, marketing, and organizational innovations. Product and process innovations are related to what are termed technical or technological innovations. Marketing and organizational innovations are recognized as new forms of innovation and belong to the group of non-technical innovations. I use the CIS data because it includes not only information on innovation performance but also on open innovation. Here a multitude of open innovation indicators can be looked at to search for the most parsimonious model that fits the data. These indicators range from innovation cooperation, external R&D, and opening up firm boundaries to the breadth of open innovation.

[18] The Oslo Manual opted for the subject approach, that is, for collecting data at the firm level, including all its innovation outputs and activities. This implies that I do not have data about individual innovation projects.

Data for CIS 2010 was gathered in 2011 by means of a voluntary postal survey for the period 2008-2010. The target population included all firms with ten or more employees. In total, 5,151 responses were received in the Czech Republic and 6,851 in Germany. I merge both datasets to total 12,002 observations.

I restrict the sample to firms with R&D intensity (ratio of internal R&D expenditures in 2008 to the total turnover of the company in 2008) lower than 0,5 (50 %) and with 10 and more employees so that I avoid biased results caused by either very small firms or firms with exceedingly high R&D intensity. Resulting in sample with 10.721 respondents.

5.4.3 Dependent variable

I use innovation performance as the dependent variable in this chapter. More specifically, I measure innovation performance by using a variable indicating the percentage of total turnover in 2010 from new or significantly improved products introduced between 2008 and 2010 (TURNIN).

5.4.4 Independent variables

a) Open innovation

To examine whether there is any moderating effect of organizational innovation and absorptive capacity on the relationship between innovation performance and open innovation practices I use a composite indicator that captures three OI practices:

- Innovation cooperation, indicating whether the firm cooperated in any of its innovation activities with other enterprises or institutions during 2008-2010. Innovation cooperation means active participation with other entities or non-commercial institutions on innovation activities. It is not necessary for both partners to benefit commercially. I exclude pure outsourcing activities without active partner involvement.
- External R&D, representing purchased creative work and innovative expertise undertaken by external enterprises (including subsidiaries within a group) or by public or private research organizations in order to increase the stock of knowledge for developing new and improved products and processes during 2008-2010.

- Opening up firm boundaries, indicating whether a firm introduced new methods for organizing external relations with other firms and institutions (i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc.) during 2008-2010. It indicates that a firm tried to extend its relationships with its environment and opened up to cooperation with external partners.
- The composite or aggregate OI indicator consequently ranges from 0 to 3.

5.4.5 Moderating variables

a) Organizational innovation

In the models, I use a construct variable measuring changes focused on internal organizational arrangements. The CIS 2010 contains two distinctive binary variables for internal organizational innovation. The first one, ORGBUP, measures the presence or non-presence of new business practices for organizing procedures (e.g. lean, quality management, supply chain) during the period 2008-2010. ORGWKP indicates new methods of organizing work responsibilities and decision making (e.g. team work, decentralization) during the same time period. I merged the two above-mentioned variables to construct a binary variable measuring organizational innovation.

b) Absorptive capacity

I measure the absorptive capacity of a firm as the intensity of its R&D activities. Many studies demonstrate a clear positive impact of these activities on business performance, measured as the number of new products introduced to the market (Olson, 2001) and/or as financial performance (Eberhart, 2004; Eberhart, 2008). In calculating the variable I follow Spithoven et al. (2013), who measures it as the ratio of internal R&D expenditures in 2008 to the total turnover of the company in 2008.

5.4.6 Control variables

a) Size

Larger companies have more resources available; they are innovative and also have more opportunities to invest in product innovation. In the models, I use the natural log of employees in 2008.

b) Industry dummies

To check for the influence of the industry for each company I use the Eurostat indicators on hi-tech industry and knowledge-intensive services (Eurostat, 2016). I created six groups of industries: low-technology industries, medium low-technology industries, medium high-technology industries, high-technology industries, low knowledge-intensive services, and knowledge-intensive services.

c) Group membership

Membership of an international group of companies is also assigned high importance to achieve sufficient innovation performance as these companies have better access to resources and direct information from the market. They also have a better capacity to develop new products. In this case, I created a dummy variable. If the company belongs to an international group, the variable value is 1 and 0 if not.

d) Country dummy

I control for a geographical association with either Germany or the Czech Republic. I created a dummy variable. If the company is based in the Czech Republic, the variable value is 1 and it is 0 for companies based in Germany.

5.5 RESULTS

Table 16 shows the mean score, the standard deviation, and the minimum and maximum scores of the variables of interest. In order to ensure internal consistency of my composite variables (open innovation and organizational innovation) I have performed principal component analysis and factor analysis resulting consistently in one significant component with eigenvalue higher than 1,0 and one factor. Based on factor loads I created a new variables Factor_OI and Factor_ORGIN.

The statistics show that the mean share of innovative products introduced during 2008 and 2010 on turnover is a bit more than 6%. The majority of firms in the sample belong to the manufacturing industry sector (55%), while almost 38% are service firms and 7% of the firms cannot be assigned to any of these groups as their NACE code does not belong to any industry described by EUROSTAT. More than half (54%) of the respondents are based in Germany,

compared to 46% in the Czech Republic. The correlations of the variables used in this study are presented in Table 17. None of the reported correlations between the variables used together in one model are high, and therefore multi-collinearity is not an issue in this study.

Table 17: Descriptive statistics

VARIABLES	Observation	(1) mean	(2) SD	(3) min	(4) max
Dependent variables					
TURNIN	10.721	6.224	17.082	0	100
Independent variables					
Factor_OI	10.721	0.045	0.800	-0.450	2.072
Moderating variables					
Factor_ORGIN	10.721	0.044	0.762	-0.538	1.326
Absorptive capacity (ABS CAP)	10.721	0.020	0.154	0	7.29
Control variables					
CZECH	10.721	0.468	0.499	0	1
GROUP	10.721	0.327	0.469	0	1
Ln_SIZE	10.721	3.824	1.602	0	12.95
MEDIUM_HIGH_TECH	10.721	0.144	0.351	0	1
MEDIUM_LOW_TECH	10.721	0.143	0.351	0	1
LOW_TECH	10.721	0.208	0.406	0	1
OTHER	10.721	0.072	0.259	0	1
KNOW_SERV	10.721	0.242	0.428	0	1
LOW_KNOW_SERV	10.721	0.134	0.341	0	1
HIGH_TECH	10.721	0.057	0.232	0	1

Table 18: Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
TURNIN (1)	-													
Factor_OI (2)	0.246	-												
Factor_ORGIN (3)	0.062	0.281	-											
ABS CAP (4)	0.323	0.190	0.020	-										
CZECH (5)	-0.315	0.115	0.072	-0.097	-									
GROUP (6)	0.017	0.161	0.146	0.018	0.076	-								
Ln_SIZE (7)	-0.016	0.078	0.216	-0.045	0.147	0.493	-							
MEDIUM_HIGH_TECH (8)	0.079	0.085	0.042	0.015	0.052	0.136	0.192	-						
MEDIUM_LOW_TECH (9)	-0.035	-0.066	0.014	-0.029	0.055	0.026	0.092	-0.168	-					
LOW_TECH (10)	-0.066	-0.194	-0.094	-0.051	0.083	-0.122	-0.049	-0.210	-0.210	-				
OTHER (11)	-0.076	-0.031	-0.000	-0.033	0.067	-0.002	0.001	-0.114	-0.114	-0.143	-			
KNOW_SERV (12)	0.049	0.132	0.004	0.085	-0.143	-0.023	-0.174	-0.231	-0.231	-0.290	-0.157	-		
LOW_KNOW_SERV (13)	-0.079	-0.118	0.035	-0.048	-0.022	-0.011	-0.029	-0.161	-0.161	-0.202	-0.110	-0.222	-	
HIGH_TECH (14)	0.161	0.160	0.022	0.063	-0.085	0.030	0.016	-0.101	-0.101	-0.126	-0.068	-0.139	-0.097	-

I use tobit regressions in the analysis as the dependent variable is continuous. I run several models in a hierarchical manner, starting with only control variables and gradually adding the independent variable, moderating variables, and interaction terms in order to check for the moderating effect of organizational innovation and absorptive capacity on the relationship between open innovation practices and product innovation, until I reach the full model. The results are shown in the table 19.

Table 19: Tobit regressions on product innovation, organizational innovation and open innovation

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
Factor_OI		15.39***			11.188***
		(0.476)			(0.443)
Factor_ORGINN			10.91***		6.215***
			(0.507)		(0.474)
ABS CAP				184.2***	123.679***
				(7.462)	(7.364)
CZECH	-22.63***	-22.05***	-22.86***	-21.20***	-21.51***
	(0.793)	(0.769)	(0.789)	(0.756)	(0.750)
GP	4.658***	1.425	2.958***	4.231***	1.040
	(0.908)	(0.883)	(0.903)	(0.865)	(0.859)
Ln_SIZE	2.101***	-0.180	0.763***	2.272***	-0.195
	(0.269)	(0.265)	(0.271)	(0.257)	(0.261)
MEDIUM_HIGH_TECH	-9.638***	-4.783***	-7.808***	-3.928**	-1.117
	(1.601)	(1.544)	(1.578)	(1.547)	(1.515)
MEDIUM_LOW_TECH	-20.95***	-12.85***	-18.43***	-12.71***	-7.913***
	(1.657)	(1.607)	(1.633)	(1.610)	(1.583)
LOW_TECH	-22.54***	-11.60***	-19.77***	-13.24***	-6.527***
	(1.589)	(1.549)	(1.567)	(1.554)	(1.532)
OTHER	-38.51***	-25.70***	-35.98***	-28.43***	-20.750***
	(2.276)	(2.214)	(2.271)	(2.189)	(2.177)
KNOW_SERV	-17.91***	-9.725***	-17.26***	-12.17***	-7.630***
	(1.526)	(1.478)	(1.503)	(1.476)	(1.448)
LOW_KNOW_SERV	-35.81***	-23.10***	-33.43***	-25.37***	-17.937***
	(1.821)	(1.767)	(1.798)	(1.765)	(1.740)
o.HIGH_TECH	-	-	-	-	-
Constant	2.882*	3.084*	6.187***	-6.967***	-1.88
	(1.646)	(1.581)	(1.621)	(1.652)	(1.629)
Observations	10,639	10,639	10,639	10,639	10,639
ll	-18723	-18147	-18480	-18422	-17934
chi2	1715	2866	2201	2316	3292
r2_p	0.0438	0.0732	0.0562	0.0592	0.0841
p	0	0	0	0	0

Model 1 consists of control variables only, followed by Models 2, 3 and 4 each of which includes either the independent variable or one of the moderating variables. Model 5 contains the results for the independent variable together with the moderating variables. The results in Model 5 confirm Hypothesis 1 and indicate that companies involved in open innovation activities have significantly higher probability of better innovation performance than those which are not engaged in open innovation. The influence of the variable representing open innovation practices supports the view that firms that are more open to cooperation with external partners have a higher probability of better innovation performance than their "closed" counterparts. However, that does not necessarily mean that firms with in-house innovation activities or with a "closed" innovation model are less innovative. Rather, it indicates that companies with dense ties to their external environment pursue many promising projects simultaneously, leading to a higher share of innovative products on turnover.

In order to infer how the effects of organizational innovation and absorptive capacity moderate the relationship between open innovation and innovation performance I estimate interaction terms. The results are reported in the table 20. Models 1 and 2 include the effect of independent variable (open innovation) and each of the moderating variables and the interaction term. Model 3 is the full model containing both moderating variables and theirs interaction terms. In order to better interpret the interaction effects I further summarized the results of model 3 in the figure 7 below.

Table 20: Interaction terms

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3
Factor_OI	14.73***	15.69***	14.64***
	(0.510)	(0.534)	(0.565)
Factor_ORGIN	-	7.872***	7.352***
		(0.530)	(0.612)
ABS CAP	197.0***		184.2***
	(10.44)		(10.40)
c.OI#c.ABS CAP	-86.01***		-76.92***
	(8.481)		(8.426)
c.OI#c.ORGCHANGE	-	-5.574***	-4.594***
		(0.533)	(0.520)
CZECH	-21.67***	-21.95***	-21.64***
	(0.753)	(0.771)	(0.756)
GP	1.405	0.901	0.909
	(0.861)	(0.883)	(0.861)
Ln_SIZE	0.213	-0.634**	-0.232
	(0.260)	(0.267)	(0.262)
MEDIUM_HIGH_TECH	-2.153	-4.188***	-1.641
	(1.521)	(1.535)	(1.513)
MEDIUM_LOW_TECH	-8.832***	-12.49***	-8.569***
	(1.590)	(1.598)	(1.584)
LOW_TECH	-6.961***	-10.98***	-6.536***
	(1.538)	(1.542)	(1.532)
OTHER	-20.60***	-25.38***	-20.49***
	(2.173)	(2.222)	(2.182)
KNOW_SERV	-7.663***	-10.36***	-8.303***
	(1.456)	(1.470)	(1.449)
LOW_KNOW_SERV	-17.83***	-22.98***	-17.90***
	(1.746)	(1.763)	(1.743)
o.HIGH_TECH	-	-	-
Constant	-3.049*	5.469***	-0.700
	(1.616)	(1.574)	(1.610)
Observations	10,639	10,639	10,639
ll	-17962	-18016	-17849
chi2	3237	3129	3463
r2_p	0.0827	0.0799	0.0884
p	0	0	0

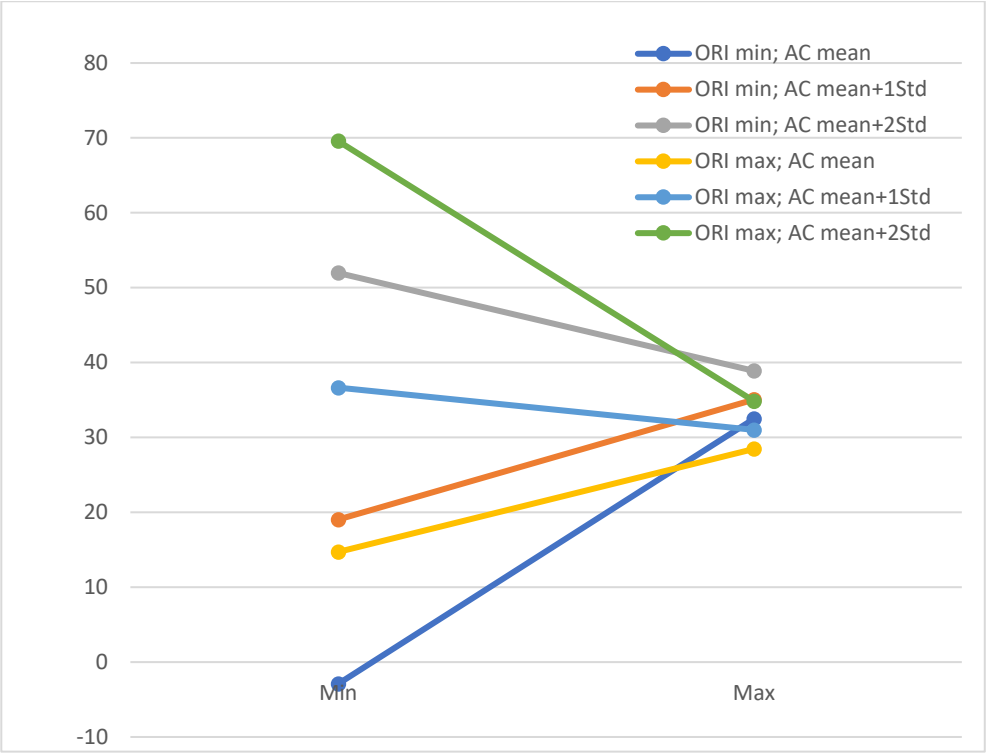


Figure 7: Innovation performance as a function of openness

I plot the minimum and maximum open innovation levels on the horizontal axis versus the dependent variable (share of sales of innovative products). The different lines represent different combinations of values for the two other variables, i.e. organizational innovation (ORI) and absorptive capacity (AC).

The first exercise consists of comparing the relationship between open innovation and innovation performance keeping the organizational innovation at minimum and increasing the values for absorptive capacity. When organizational innovation is non-existent (ORI = min) and absorptive capacity is measured at its mean (dark blue line) the line is quite steep indicating that open innovation has a major impact on innovation performance. When absorptive capacity is increased (AC at the mean + 1 x standard deviation, orange line), the curve start at higher intercept value, but the slope is much less steep. In case absorptive capacity is measured at high value (Mean + 2 x standard deviation) then the intercept is

pretty large and the slope is negative (grey line). The result is that the three lines are converging to intermediate values when a firm engages into the open innovation initiatives and internal R&D simultaneously. In other words, absorptive capacity has (1) its own positive effect on innovation performance, but (2) that effect levels off as open innovation and AC levels increase simultaneously and (3) at the highest level of absorptive capacity open innovation doesn't have almost any impact no more on innovation performance. Absorptive capacity is thus a complement for open innovation when the level of organizational innovation is at minimum and a substitute when the organizational change is at maximum value.

The second exercise consists of comparing the relationship between open innovation and innovation performance keeping the value of organization innovation at maximum while increasing the value of absorptive capacity. When I take AC at its mean value, I find a positive effect of organizational innovation at minimum level of open innovation, but at maximum level of OI the effect becomes negative (yellow line). The same holds for higher values of absorptive capacity: that is for the values representing "mean + 1 standard deviation" (light blue line) and "mean + 2 standard deviations" (green line). In other words, organizational innovation has (1) its own positive effect on innovation performance, but (2) its effect is annihilated and even negative at maximum open innovation value. Organizational innovation is thus a substitute for open innovation in improving the innovativeness of firms and there is even a negative effect on innovation performance when firms try to increase absorptive capacity if they are already engaged in the open innovation initiatives. Based on the results the hypotheses 2 and 3 are not confirmed.

5.6 DISCUSSION AND CONCLUSIONS

This chapter examines the factors influencing the open innovation performance relationship using a sample of 10,721 firms covered by the Community Innovation Survey 2010 in Germany and the Czech Republic. I distinguish among three different open innovation approaches (innovation cooperation, external R&D, opening up firm boundaries) that increase the probability of successful innovation performance. Additionally, I investigate the boundary conditions of this relationship by including organizational innovation and absorptive capacity as moderating factors. In exploring these issues the thesis

provides fresh empirical evidence of the factors influencing the much-studied open innovation performance relationship. I thus provide a more comprehensive picture of the context dependencies of open innovation (Huizingh, 2011).

The main findings contribute to the open innovation literature in several ways. First, I offer empirical evidence on the relationship between different open innovation approaches and innovation performance, following Spithoven et al. (2013). All indicators associate positively and strongly with the innovation performance.

Second, I am not constrained by any specific industry but rather are able to show results for both the manufacturing and service sectors.

Third, contrary to my expectations, both organizational innovation as well as absorptive capacity have a negative moderating effect on innovation performance when a firm simultaneously engages in open innovation. The negative effect of absorptive capacity could be explained by pointing out that firms engaged in open innovation potentially also face the same requirements for R&D investments as firms that are only relying on in-house R&D. The consequence of negative moderating effect of organizational innovation (in combination with the positive effect of organizational innovation on innovative performance) is that firms have to combine open innovation and organizational innovation up to specific level beyond which the innovation performance drops again. A direct consequence of these results is that performance effects of open innovation should not be studied in isolation of other factors that have a major impact on performance as well.

Although there is a need for new capabilities and organizational arrangements within the companies for them to be able to fully exploit the potential of, and manage, technological innovation activities, previous research has also acknowledged the role of internal barriers, not-invented-here phenomena, and resistance to change as barriers to successful open innovation (Chesbrough, 2006). Change might be good in the long run (Teece, 2009); in the short run it might induce uncertainty and require resources that cannot be spent on open innovation projects. As a result of organizational innovation, firms' priorities may alter or need to be adapted to current needs and they thus abandon current R&D/innovation projects in the short run.

5.6.1 Limitations and further research

This study contributes to the open innovation literature by analyzing an important yet underexplored topic, namely the effect of organizational innovation and absorptive capacity on the relationship between open innovation and innovation performance. Informative though it may be, this study has several limitations. First, the empirical evidence presented in this chapter should be considered carefully as data collected in innovation surveys is quantitative, subjective, censored, and cross-sectional in nature, which does not allow for strong causal claims (Mairesse & Mohnen, 2010). In this vein, I lack project-level information and hope that future research can look in more detail into the causal effects of organizational innovation and open innovation at a project level.

The second limitation of this study lies in the fact that the survey is subjective and based on the assertions of individual firms. Although the reliability and validity of the survey have been established, some questions may remain slightly subjective and rely on the perception of the respondent and his/her involvement in innovation activities.

Third, the results of the study indicate that firms embracing the "open innovation" approach have a higher probability of developing new products than their "closed" counterparts. But the study does not capture whether the firm is open to collaboration during all the stages of product innovation. Thus, I cannot be sure whether there are any stages during which it is critical to cooperate or, on the other hand, whether there is a step which should be taken solely by the firm on its own. I believe that future research should shed light on a more fine-grained evaluation of innovation cooperation throughout the whole product development cycle.

Finally, data shows that organizational innovation has a positive moderating effect on the relationship between open innovation activities and innovation performance, measured by product innovation. As in the above-mentioned examples, the dataset does not provide us with the information regarding the scale and "quality" of the organizational innovations carried out by the firm. This opens up interesting avenues for further qualitative research exploring the nature and especially the degree to which a firm needs to adjust its organizational

arrangements in order to make the most of the potential of applying open innovation to product innovation.

5.6.2 Managerial recommendation

The main findings contribute to open innovation management in several ways. The results have some clear managerial implications. First, as organizational innovation is consistently associated with hampering the relationship between innovation performance and open innovation practices, firms need to possess organizational agility or dynamic capabilities to thrive when engaging in open innovation partnerships. Therefore, it is important to find the right organizational setting for open innovation, regardless of the industry sector and the quality of the innovation. The firm has to search continuously for changes in its working procedures and business practices in order to fit the market demands and develop commercially viable products, which further supports active engagement in external R&D or collaborative partnerships. Second, engaging in open innovation might also require a redirection of the company's overall strategy (Vanhaverbeke et al., 2017). More specifically, open innovation partners can dramatically shape firms' strategy from development to execution. In ever more dynamic environments, firms have to adapt quickly to market needs, which will only be possible if they can flexibly adjust their strategy and use internal as well as external knowledge sources. Thus, for a firm to realize its full potential, it needs to connect its open innovation endeavours with its strategy development initiatives and have a certain level of organizational agility (Vanhaverbeke et al., 2017).

6 CONCLUSIONS

In this thesis I attempt to advance current knowledge about the complex relationships between organizational innovation, new product development and open innovation by answering the main research question: *"What are the firm-level determinants of innovation performance measured by product innovation and innovation termination from open innovation point of view"?* In general, I argue that if companies want to be competitive in quickly changing business environments they need to change continuously. There is never a perfect fit between a company's strategy, organizational structure, people, processes and the business environment (Simanis & Hart, 2009) and thus competitive advantage has become more temporary than before creating a need for continuous strategic renewal (Kriz et al., 2014; McGrath, 2013). Those firms focused only on the existing capabilities have disproportionally higher rates of failure compared to their more flexible counterparts (Leonard-Barton, 1992). To be able to adapt, firms must hold the necessary skills, capabilities or resources to do so. It can also be argued that adaptation requires that firms not only effectively manage their current resource bases but also develop flexibly to change their resource positions to respond to dynamic market conditions. In other words a firm needs dynamic capabilities to reconfigure its own resources to respond to specific environmental changes (Zollo & Winter 2002).

In dynamic capabilities, the term "dynamic" refers to the capacity to renew a company's competences to adapt to the changing business environment as well as to create innovative responses to visible future market and competition demands. The term "capabilities" refers to the role of a company's management to adapt, integrate and reconfigure internal and external organizational skills, resources and competences to match the changing environment. Thus, dynamic capabilities reflect a company's ability to create and gain new and innovative sources of competitive advantage with its path dependencies and existing market positions (Teece et al., 1997).

To make things a bit more complicated, it seems to be increasingly obvious that companies are not able to renew their activities and competencies on their own. For many organizations, the technology is moving too fast and its increased complexity is leading many firms to opt to leverage their in-house competencies

with externally available technological resources and capabilities. These purposive inflows and outflows of technology and knowledge to accelerate internal innovation and expand the markets for the external use of innovation have been termed "open innovation" (Chesbrough, 2003). Most of the time open innovation literature focused on how to reach out to potential partners, explaining why to reach out, recommending to whom to reach out, and describing how to reach out. Only recently literature touched upon how to restructure internally to be successful in open innovation (Chiaroni et al., 2010, 2011; Enkel et al., 2011).

Organizational renewal and open innovation activities are realized through new product development, which is a focal point of this thesis. More specifically, based on CIS 2010 data I examine the effect of organizational innovations on product innovation, I look for factors associated with innovation termination and I further investigate effects of organizational innovations and absorptive capacity on the relationship between open innovation and product innovation. In the next section I answer the three research questions which have been functioning as a guideline for the whole thesis.

6.1 ANSWERS TO RESEARCH QUESTIONS

1) Are organizational innovations of a firm (particularly introduction of new internal procedures) and open innovation activity (measured by methods of organising external relations) associated with innovativeness of a firm (measured by product innovation)?

I investigated the relationship between organizational innovation, open innovation activities and product innovation. In particular I wanted to shed light on whether there are any differences in the organizational innovations required for both radical and incremental product innovation in the manufacturing and service industries. And to look for potential complementary and/or substitution effects among organizational innovation and open innovation activities.

The results of Chapter 3 show that successful product innovation requires changes either in the internal procedures and decision-making processes or in the methods of organizing external partnerships (open innovation measure). This finding applies to product innovation in the manufacturing as well as service industries. The results further show that when firms introduced both organizational innovation and open innovation simultaneously the probability to

introduce a new product on the market is even higher. The interaction term of both (dummy) variables is negative but the effect is too small to annihilate the combined effect of changing both internal procedures and decision-making processes on the one hand and the organization of external partnerships on the other hand. In other words, firms that are engaging both organizational innovations and open innovation are more likely to report new product innovations.

There is an interesting difference between incremental and radical product innovation in relation to the impact of external partnerships on the likelihood that firms report innovations. The results show that working with partners increases the likelihood of a new radical innovation to a much low extent than in the case of incremental innovations. This clearly shows the risky nature of radical innovations: innovating with partners will lead to a radical innovation in a lower percentage of the cases than in the case of an incremental innovation, where the success rate is (almost per definition) much higher. I should therefore differentiate among various types of organizational and open innovations and the "quality" of product innovation as the effects vary significantly depending on the type of product innovation (radical or incremental) a firm embraced.

The results also show that large, R&D intensive, multinational companies have a significantly higher probability to introduce new products on the market than their counterparts. This is an interesting result, but it can also reflect a bias in the data, since large firms have many projects and the questionnaire is conducted at the firm level. In other words, even when large firms would be less effective in developing an innovation at the project level, they report at the firm level a higher propensity to generate innovations as the dependent variable is not the number of innovations but simply a yes or no answer whether the firm has introduced innovative products in the last 3 years.

2) What are the firm-level factors determining the termination of an innovation endeavors by firms?

Studying this question is particularly important since many firms spend a significant budget on innovation projects that are not reaching commercialization. First, these expenditures embody a sizable investment for many firms and may have a significant impact on their current and future financial position, as well as

on their ability to compete technologically. Second, projects often entail company-wide commitments that translate into large opportunity costs if improperly managed (Bard, 1988). Third, being able to recognize unfeasible projects (earlier) avoids sunk investments and releases resources that can be invested in more profitable projects.

By answering this question I wanted to (1) shed light onto the factors influencing innovation project termination and (2) thus provide solutions to managers to avoid late and costly project terminations. Additionally, firms can build a capability to learn from terminated innovation projects and incorporate best practices into future processes with a remarkable positive impact on future profitability and on chances of survival (Leoncini, 2016).

The results indicate a significant positive influence of size of the company, organizational innovation and level of internationalization on innovation project termination. The influence of the 'research activities' supports the view that the more the firm is involved in research activities the higher the probability of innovation project termination. In that sense I can argue that large companies involved in agile organizational settings with multiple simultaneous research activities are more prone to abandon innovation projects than their smaller counterparts with little R&D activities. That does not necessarily mean that larger firms are less innovative. Rather it indicates that larger companies with greater R&D budgets pursue many projects simultaneously leading to a higher attrition rate during the selection process which is due to a more formalized and objective screening process. On the other hand, smaller, resource-constrained firms are forced to make tough decisions about a handful of "safe bets" leading to a lower rate of terminated projects. Firms that are agile and flexible are more likely to terminate innovation projects because they constantly recombine existing resources and evolve in new directions, which open up different opportunities and create input for repeatable, new innovation projects on the one hand but also lead to a higher attrition rate where only few "winners" will successfully come out of the funnel. The level of internationalization is also positively linked with the likelihood to terminate an innovation project. Firms that operate on a highly international level are also more likely to carry out several projects simultaneously to compete at the technological frontier. Having more projects in the pipeline

allows them to focus on those projects that are most promising and terminate those that have the least chances of success. Interestingly, I have found that marketing innovation is also significantly associated with innovation project termination. This finding could be explained by the fact that market information and professional screening of the market potential of a new innovation will lead to more formalized scrutiny of the project's progress and hence it will be terminated earlier when market expectations are not met.

3) What impact do organizational innovation and absorptive capacity have on the relationship between open innovation practices and the innovation performance of a firm?

In answering this question I want to shed light onto whether organizational innovation and absorptive capacity augment or weaken the positive effect of open innovation on innovation performance.

I find that there is a pronounced effect of open innovation activities on innovation performance measured by percentage of total turnover in 2010 from innovative products. Interestingly, the findings show that absorptive capacity has its own positive effect on innovation performance, but it levels off the effect of open innovation up to a level that at the highest level of openness absorptive capacity doesn't have any impact on innovation performance. Absorptive capacity is thus a substitute for open innovation in improving the innovativeness of firms. I find similar results for organizational innovation which is also a substitute for open innovation in improving the innovativeness of firms.

I distinguish among three different Open Innovation approaches (innovation cooperation, external R&D, opening up firm boundaries) and composed an open innovation index with a maximum value of 3. This variable has strongly increased the share of the sales coming from new products. Additionally, I investigate the boundary conditions of this relationship by including organizational innovation and absorptive capacity as moderating factors. Both factors have strong positive effects on innovation, but in contrast with the hypotheses, I find two negative interaction terms with open innovation. This is not the first study finding a similar result. Laursen & Salter (2006) and Chen et al., (2011) are two examples where the same effect was discovered. This result indicates that open innovation should not be considered in isolation from other factors that can contribute to a better

innovation performance such as internal R&D and organizational innovation. As they as substitutes these two factors erode the positive effect of open innovation on innovation performance up to a level that open innovation no longer has an effect. In exploring these issues the thesis provides fresh empirical evidence of the factors influencing the much-studied relationship between open innovation and innovation performance. It thus provides a more comprehensive picture of the context dependencies of open innovation.

6.2 THEORETICAL IMPLICATIONS

The thesis contributes to innovation project management and open innovation literature. Dealing with innovation project management I explored two sub-topics: successful product innovation and innovation project termination. Regarding product innovation the thesis contributes to the literature in several ways. First, it brings additional empirical evidence on the relationship between various activities aimed at changing the organizational arrangements and the propensity to innovate. Given the relatively new significance of organizational innovation in the literature and the recent interest in the relationships among various innovation types and performance (either financial, or technological), existing studies do not provide conclusive results on these questions. This is mainly because of inconsistencies in the perception and use of the organizational innovation concept (Damanpour & Aravind, 2011) and to the tendency to study joint effect of different types of innovation activities on firm performance (Calantone et al., 2002) without differentiation among effects of different innovation types.

The results provide some important contributions. They enhance the understanding of the effects of organizational innovation and open innovation on the generation of product innovation. Although it is not possible to state causal relationship due to the cross-sectional nature of the data, the present study expands on the original research supporting a correlation between the two innovation strategies and product innovation (Damanpour et al., 1989) and more recent studies revealing complementarity between these different types of innovation (Battisti & Stoneman, 2010; Damanpour et al., 2009). Furthermore the interrelationship found among organizational and open innovation also helps better understanding of the complex process through which different types of innovation activity affect performance.

With respect to project termination the thesis offers empirical evidence on the relationship between various factors and the propensity to abandon an innovative project. First, I find that larger firms tend to abandon more innovation projects than their smaller counterparts. Large firms have the advantage that they can rely on formalized evaluation methods of innovation projects, which reduces the chance of an escalation of commitment to projects with poor prospects. On top of that, they can rely on major portfolios of innovation projects and will in comparison with small firms more easily start to finance innovation projects. Small firms are more selective and only start projects when there is a good chance that they will turn into a commercial success. Second, I find that firms that are more systematically involved in (internal and external) R&D activities have a higher propensity to abandon innovation projects. Companies conducting R&D in a systematic way are more formalized and therefore termination of projects will be decided based upon objective criteria. Third, firms that develop new business practices (e.g. increasing agility, quality management, supply chain management) and new methods of organizing work responsibilities, decision making, and organizing relationships with other firms and institutions, also are inclined to abandon more non-promising innovation projects than their counterparts that are not developing this organizational agility. Fourth, I find that firms that internationalize have to compete in different markets with strong competitors but they also leverage innovations across different markets earning a greater return on innovative products. Therefore, they may be more determined to take more risks and start more projects, leading to more projects that will be terminated. On top of that, internationally operating companies are likely to develop objective procedures regulating how to terminate innovation projects, reducing in this way the risk of escalation of commitment by individual managers. Finally, I find no evidence for the hypothesis that marketing innovation would lead to a reduction in the termination of R&D projects. I argued that the stronger marketing capabilities of a firm would lead to lower risks of innovation project termination. The opposite seems to be true. I might explain this surprising result by the fact that firms developing strong marketing capabilities such as new product promotion techniques, new product positioning methods and new pricing methods have additional instruments in their hands – besides the typical tools to objectively estimate the technology performance of a project – to reject unpromising projects.

The thesis brings also several contributions to open innovation literature. On the general level the findings show that open innovation has to be integrated into organizational change literature. It is not possible to keep these two streams of literature separated anymore given the strong positive impact of internal organizational innovation on performance and its tampering effect on the relationship between open innovation and innovation performance. Successful implementation of open innovation requires an internal reorganization of the company which is a challenging endeavour. Organizational design, role of people, change of the incentives and routines come to play.

On a more specific level there are several contributions. The thesis offers empirical evidence on the relationship between different open innovation approaches and innovation performance. All open innovation variables show a positive and strong effect on the likelihood of introducing product innovations. Contrary to my expectations, internal organizational innovation has a negative moderating effect on the relationship between open innovation and innovation performance. The consequence of this negative moderating effect (in combination with the positive effect of organizational innovation on innovative performance) is that firms have to combine open innovation and organizational innovation up to specific level beyond which the innovation performance drops again. A direct consequence of these results is that performance effects of open innovation should not be studied in isolation of other factors that have a major impact on performance as well.

6.3 MANAGERIAL IMPLICATIONS

The results of the previous chapters have some managerial implications. First, as organizational innovation is consistently associated with significantly higher propensity to product innovation, independent of industry and type of innovation, there is a need to find the right organizational setting for innovation. The firm has to continuously search for changes in its working procedures and business practices in order to fit the market demands and make commercially viable products. Second, changes in organizational arrangements (either in internal procedures or external relationships) of a firm should correspond with the needs of product innovation. That is, changes in internal decision-making procedures and organizational structure without the development of formal and informal ties

with external partners (either science-based or market-based) will lead to dire consequences for innovativeness. Or, vice versa, a firm with many external relationships and with a continuous inflow of new ideas and knowledge but without internal procedures and without good internal product innovation management, will end up into serious problems. Organizational innovations should be thoroughly planned, implemented step-by-step and continuously evaluated in order to avoid frictions and stressful situations within the organizational structure.

The main findings of this thesis also contribute to open innovation management in several ways. First, as organizational innovation is consistently associated with hampering the relationship between innovation performance and open innovation practices, firms need to possess organizational agility or dynamic capabilities to thrive when engaging in open innovation partnerships. Therefore, it is important to find the right organizational setting for open innovation, regardless of the industry and the type of the innovation. The firm has to search continuously for changes in its working procedures and business practices in order to fit market demands and develop commercially viable products, which further supports active engagement in external R&D or collaborative partnerships. Second, engaging in open innovation might also require a redirection of the company's overall strategy (Vanhaverbeke et al., 2017). More specifically, open innovation partners can dramatically shape firms' strategy from development to execution. In ever more dynamic environments, firms have to adapt quickly to market needs, which will only be possible if they can flexibly adjust their strategy and use internal as well as external knowledge sources. Thus, for a firm to realize its full potential, it needs to connect its open innovation endeavors with its strategy development initiatives and have a certain level of organizational agility (Vanhaverbeke et al., 2017).

The results of chapter 5 show that – in contrasts to the hypothesized effects – internal R&D and organizational innovations act as substitutes for open innovation. That implies that managers have to carefully balance the combination of the three methods (internal R&D, open innovation and organizational innovation) as excessive use of two or all three of them will certainly lead to suboptimal innovation performance. I calculated that best innovation performance levels are obtained for combinations of intermediate values of the three methods.

Hence, managers have to combine open innovation with some internal R&D and organizational innovations.

6.4 LIMITATIONS AND FURTHER RESEARCH

The empirical evidence presented in this thesis should be considered carefully for several reasons. First, the results are based on broad cross-sectional dataset. The main indicators, 'organizational innovation', 'product innovation', and 'radical and incremental innovation' adopted by CIS are static yet measuring dynamic processes. This is a general drawback of any cross-sectional dataset. There should be a time lag between independent and dependent variables to induce causality but this is not the case for the CIS data. Second, the data collected in innovation surveys are quantitative, subjective, censored and cross-sectional in nature which does not allow for strong causal claims (Mairesse & Mohnen, 2010). Third, CIS-data are firm level data and therefore the thesis lacks project-level data so that the thesis can neither account for the number of projects the firms in the sample simultaneously work on nor the absolute number of projects they terminated. I also do not possess information at which stage of the process the projects were terminated. Thus, I cannot link effective termination of innovation projects to firm level innovation performance. These limitations prevented me of exploring the research topics in greater depth: working with fine-grained data would offer the potential to explore many other interesting research questions.

Another limitation of this study lies in the fact that the survey is subjective and based on assertions of individual firms. Although reliability and validity of the survey have been established, some questions may remain slightly subjective and rely on the perception of the respondent and his/her involvement in innovation activities.

What also needs to be taken into account is the fact that renewal processes are much broader than new product development and its antecedents. The CIS data lacks the information about cultural issues, entrepreneurial climate, management styles and other important factors influencing the overall organizational renewal.

While the thesis provides important contributions and shows that changes in organizational arrangements and open innovation practices can be drivers of

product innovation, some questions remain unanswered providing exciting opportunities for further research. The findings highlight that changes to both internal processes such as business practices and new methods of organizing work responsibilities and new methods of organizing external relations are significant predictors of product innovativeness if implemented separately; and if a firm implemented both types of organizational innovation at the same time the probability to introduce a new product on the market was even higher. There is an interesting difference between incremental and radical product innovation in connection with external partnerships, indicating that firms are still not very open to collaboration with external partners on products which are radically new. On the other hand, they are very used to involving third parties in incremental improvements to their product lines. Although I provided some explanation for this phenomenon. This could provide an interesting opportunity for future research: are firms significantly less willing to collaborate on radically new innovative projects with third parties compared to incremental product innovation? Another problem that arises is the capacity of managers to maintain and control all the organizational innovations at the same time. Hence, it might be more difficult to handle changes of different types (e.g., internal procedures vs. external relationships) than of one type. Therefore, it is interesting to shed light on the innovation process literature by examining whether the (coordination, transaction cost) effort increases when a firm engages e.g., in organization-wide changes related to improve its innovation performance, and compare it to the effort of handling carefully planned incremental changes implemented step by step. Thus, future research could investigate firms' approaches to different kinds of organizational innovations and how they correspond to the needs of product innovation. Furthermore, the findings in this thesis do not take account of the stage and scale of the organizational innovation. Including this type of information would improve the managerial relevance of this research.

While the thesis shows that firm size, research activities, level of internationalization as well as organizational agility can be important factors for innovation project termination, some questions remain unanswered, which, in turn, provides exciting opportunities for further research. The findings do not account for the frequency or number of the firm's innovation project terminations.

Nonetheless, this indicates a potential for organizational learning triggered by the negative experience. In this line, this leaves room for firms to design an organizational culture that strongly supports employees' to learn from the termination of unpromising projects, rather than considering each project termination as a failure. This opens up interesting avenues for further research using organizational learning theory (e.g., Argote, et al., 1990, Chiesa & Frattini, 2011, Lampel et al., 2009) to analyze firms' development of an innovation project management capability to reduce the likelihood of unwanted terminations of innovation projects. Therefore, it would be interesting and highly rewarding for theory building concerning the creation of firms' innovation project management capability to investigate the drivers and reasons of the termination. In light of the organizational learning and dynamic capabilities literature (Teece et al., 1997, Winter 2003, Eisenhardt & Martin, 2000, Zollo & Winter, 2002), further research should focus on learning from project terminations (and its intrinsically dynamic nature) and whether this increases or decreases the number of future project terminations.

Furthermore, I encourage future research to take a multi-level perspective by combining project and firm level factors of innovation project termination to gain a more holistic understanding. I also suggest extending the findings by specifically differentiating between innovation projects building on core/non-core technologies and their impact on innovation project termination. Innovation projects building on core-technologies might be less prone to termination than projects that are more radical and/or based on non-core technologies.

Moreover the results indicate that firms embracing the "open innovation" approach have a higher probability of higher innovation performance than their "closed" counterparts. But the thesis does not capture whether the firm is open to collaboration during all the stages of new product development. Thus, one cannot be sure whether there are any stages during which it is critical to cooperate or, on the other hand, whether there is a step, which should be executed solely by the focal firm. Future research should shed light on a more fine-grained evaluation of innovation cooperation throughout the whole product development cycle.

Finally, data shows that organizational innovation has a negative moderating effect on the relationship between open innovation activities and innovation

performance. As in the above-mentioned examples, the dataset does not provide the information regarding the scale and "quality" of the organizational innovations carried out by the firm. This opens up interesting avenues for further research exploring the nature and especially the degree to which a firm needs to adjust its organizational arrangements in order to make the most of the potential of applying open innovation to product innovation.

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