UNIVERSITY OF LJUBLJANA
FACULTY OF ECONOMICS

ALEŠ PUSTOVRH

OPEN INNOVATION AND ITS EFFECTS ON THE GROWTH STRATEGIES OF SMALL AND MEDIUM-SIZED COMPANIES

DOCTORAL DISSERTATION

Ljubljana, 2014

AUTHORSHIP STATEMENT

The undersigned **Aleš Pustovrh**, a student at the University of Ljubljana, Faculty of Economics, (hereafter: FELU), declares that I am the author of the doctoral dissertation entitled **OPEN INNOVATION AND ITS EFFECTS ON THE GROWTH STRATEGIES OF SMALL AND MEDIUM-SIZED COMPANIES**, written under supervision of **Prof. Dr. Marko Jaklič**.

In accordance with the Copyright and Related Rights Act (Official Gazette of the Republic of Slovenia, Nr. 21/1995 with changes and amendments) I allow the text of my doctoral dissertation to be published on the FELU website.

I further declare

- the text of my doctoral dissertation to be based on the results of my own research;
- the text of my doctoral dissertation to be language-edited and technically in adherence with the FELU's Technical Guidelines for Written Works which means that I
    - cited and / or quoted works and opinions of other authors in my doctoral dissertation in accordance with the FELU's Technical Guidelines for Written Works and
    - obtained (and referred to in my doctoral dissertation) all the necessary permits to use the works of other authors which are entirely (in written or graphical form) used in my text;
- to be aware of the fact that plagiarism (in written or graphical form) is a criminal offence and can be prosecuted in accordance with the Copyright and Related Rights Act (Official Gazette of the Republic of Slovenia, Nr. 55/2008 with changes and amendments);
- to be aware of the consequences a proven plagiarism charge based on the submitted doctoral dissertation could have for my status at the FELU in accordance with the relevant FELU Rules on Doctoral Dissertation.

Date of public defence: 5.12.2014
Committee Chair: prof. dr. Miha Škerlavaj
Supervisor: prof .dr. Marko Jaklič
Member: prof. dr. Sandra Penger
Member: prof. dr. Peer .Hull Kristensen

Ljubljana, 5.12.2014 Author's signature: _____

Acknowledgements

First, I would like to formally acknowledge the financial support I've received. This dissertation was part of an operation financed by the European Union, European Social Fund. Operation implemented in the framework of the Operational Programme for Human Resources Development for the Period 2007-2013, Priority axis 1: Promoting entrepreneurship and adaptability, Main type of activity 1.1.: Experts and researchers for competitive enterprises. Without this financial support, no research would be feasible.

My warmest thanks go to my family. They have endured a lot and have shared the burden of preparing a PhD thesis even though they will not be able to share any results. Petra, Karlina and Ana have remained supportive even under difficult circumstances and I will do my best to repay their trust and make up for the lost time that I've spent researching instead of being with them. My mother Danica, father Anton, my sister Saša and my aunt Zdenka have also supported me in my research journey. Even though it also affected them, they remained supportive all the way till the end.

I am deeply grateful to my dissertation supervisor, Marko Jaklič. Without his support and motivation, mentorship and enlightened insights into the intricate world of academic research, my aspiration to become an academic could have faltered. He has always been available for any kind of questions, sharing his thoughts and critically evaluating my results. His creative thinking and innovative ideas are second to none and a source of great interest for every aspiring scholar. At the same time, he left me with sufficient freedom to pursue my own path. It takes a great strength of character to allow people to do what they wish while guiding them from a distance to do it well. For that reason, Professor Jaklič was an ideal mentor for me and I am very grateful for the chance and opportunity to have worked (and continue to work) with such an exceptional scholar and person. I also express my gratitude to my dissertation jury for taking the time to approve my research proposal, for reviewing my contributions and for providing valuable feedback.

I also want to thank my friends and colleagues at the University of Ljubljana and at the Laboratory for Open Innovation Systems (LOIS) for their help and assistance. Matevž Rašković, Matej Černe and Ivan Župič have contributed towards the development of the research approach and analysis used in the thesis and have shared their knowledge in a truly open manner, expecting nothing in return. Sabina, Darija, Miha and Mladen have all influenced my work and contributed to creating a good working environment. Matjaž, Miha, Carlos, Ani, Miha and other schoolmates from my PhD class have walked along me on this research journey and know best of its difficulties. Marko Pahor, Petra Vranješ and Lidija Urek have gone out of their way to assist in all administrative and other matters, allowing me to focus solely on research.

I sincerely thank you (and those that I've forgot) all.

ODPRTI INOVACIJSKI SISTEMI IN NJIHOVI UČINKI NA STRATEGIJE RASTI MALIH IN SREDNJE VELIKIH PODJETIJ

Povzetek

Inovacije so postale globalne in odprte na način, ki je bil še pred 20 leti nepredstavljiv (Wooldridge, 2010). Podjetja danes inovirajo v okolju, kjer je konkurenca globalna, znanje bolj razširjeno kot kdajkoli prej, kjer se investicije v raziskave in razvoj povečujejo in kjer se življenjski cikel izdelkov krajša (Koen De Backer, Cervantes, Van De Velde, & Martinez, 2008). Te spremembe so vplivale na nove raziskave inovativnosti. V zadnjem obdobju se je z razvojem novih konceptov razvilo tudi raziskovanje inovativnosti. Eden od njih je koncept odprtih inovacij (Chesbrough, 2003). Odprti inovacijski sistemi so tisti, kjer podjetja poleg lastnih uporabljajo tudi ideje, ki nastajajo izven okvirjev lastnega podjetja. Prav tako zanje iščejo notranje in zunanje poti do trga. Raziskave in razvoj predstavljajo odprt sistem (Chesbrough & Crowther, 2006).

Raziskovanje koncepta odprtih inovacij je glavni raziskovalni cilj moje dizertacije. Prvi raziskovalni cilj dizertacije je predstavitev intelektualne strukture koncepta odprtega inoviranja ter njegova umestitev v raziskovanju inovativacij in inovacijskih aktivnosti. Namen mojega dela v prvem poglavju je ugotoviti, ali koncept odprtih inovacij prispeva k zapolnitvi vrzeli v razumevanju inovativnosti. Ugotovil sem, da je koncept odprtega inoviranja nov koncept, ki ne bo hitro zamrl. Čeprav ne predstavlja nove paradigme v raziskovanju inovativnosti, pa vsekakor ne predstavlja komunikacijske ovire ali zavore za nadaljnje raziskave, kar trdijo nekateri kritiki.

Koncept odprte inovativnosti je prispeval k širšemu razumevanju inovativnosti, prav tako pa je prepoznal področja, kjer ostajajo vrzeli za nadaljnje raziskovanje. Prepoznal sem tudi nekaj ožjih raziskovalnih področij, ki predstavljajo vrzeli v konceptu in zato priložnosti za nadaljnje raziskave. Ekonomski učinki aktivnosti odprtega inoviranja do sedaj niso bili dovolj dobro raziskovani. Predvsem empirične raziskave še vedno ostajajo redke, še posebej na skupini malih in srednje velikih podjetij. Druga vrzel je organizacija inovacijskih skupnosti in vzpostavitev javnih politik, ki podpirajo aktivnosti odprtega inoviranja ter koriščenje njihovih družbenih koristi.

Ta področja predstavljajo osnovo za ozko usmerjene raziskave, ki so obravnavane v naslednjih poglavijh disertacije. V drugem poglavju sem raziskoval poslovno aplikacijo aktivnosti odprtega inoviranja v malih in srednje velikih podjetjih. Na podlagi zbranih podatkov o uporabljenih praksah odprtega inoviranja med 105 visokotehnološkimi malimi in srednje velikimi podjetji sem oblikoval strukturni model enačb. Oblikovani model testira predhodnike, ki vplivajo na komercializacijo inovacij v visokotehnoloških malih in srednje velikih podjetijh. Rezultati potrdijo prisotnost močne in pozitivne povezave med inovativnostjo in dejavniki komercializacije v visokotehnoloških malih in srednje velikih podjetijh.

Najpomembnejši doprinos te raziskave pa je prikaz vpliva dveh konkretnih praks odprtega inoviranja – izmenjavanja informacij ter inovacijskega sodelovanja – na omogočanje komercializacije inovacij. To poteka z vplivom na njihove inovacijske aktivnosti ter z vplivom na inovativnost. Hkrati ugotavljam, da visokotehnološka mala in srednje velika podjetja, ki se odločijo za široko razvejano inovacijsko sodelovanje z zunanjimi partnerji, postanejo bolj inovativna, to pa jim omogoči boljšo komercializacijo inovacij. Pomemben prispevek te raziskave je vpogled, da komercializacija ni samo neposredno povezana z aktivnostmi odprtega inoviranja, ampak pokaže tudi jasen mehanizem aktivnosti (vpliv preko inovativnosti). Za podjetja pa je ugotovitev jasna – večja odprtost ne vpliva samo na povečanje inovativnosti, ampak tudi na uspešnejšo komercializacijo njihovih rezultatov.

V tretjem in četrtem poglavju sem se posvetil implikacijam odprtega inoviranja na inovacijske politike. V tretjem poglavju z uporabo kvantitativne primerjalne analize mehkih množic na podatkih o inovacijskih politikah držav članic Evropske unije demonstriram, da lahko raziskovanju inovacijskih politik koristi uporaba novih raziskovalnih metod. Za demonstracijo sem uporabil analizo nujnosti povezav in podjetništva, dveh skupin inovacijskih aktivnosti, ki jih vsebuje koncept odprte inovativnosti.

V poglavju pokažem, da je uporaba korelacijskih statističnih metod za analizo nacionalnih inovacijskih politik neprimerna zaradi njihove vzročne kompleksnosti, ki jo standardne statistične metode ne morejo upoštevati. Pomembnost vzročne kompleksnosti je prikazana s testiranjem hipoteze o posebni pomembnosti inovacijskih politik na področju povezav in podjetništva, ki predstavljajo potrebni pogoj za vsako inovacijsko uspešno državo. Raziskava potrdi vzorčno kompleksnost inovacijskih politik in s tem predpostavko, da so za njihovo raziskovanje potrebne drugačne raziskovalne metode. Prav tako pa potrdi pomembnost koncepta odprtega inoviranja s potrditvijo hipoteze, da so tako inovacijske povezave kot podjetništvo nujni za inovacijsko uspešnost držav.

Raziskave inovacijskih politik sem nadaljeval in razširil v četrtem poglavju z raziskavo različnih politik in njihovega vpliva na pozicioniranje inovacijske dejavnosti v okviru nacionalnih inovacijskih sistemov. Zaradi globalizacije inovacijskih ekosistemov so vse politike, ki lahko olajšajo ustanavljanje inovacijskih središč v okviru nacionalnih inovacijskih sistemov, obravnavane kot politike, ki vplivajo na inovacije. To pomeni, da sem analiziral ne le 'ozke' inovacijske politike, ki so posebej usmerjene na inovativne ukrepe, ampak tudi 'širše' politike, ki vplivajo na značilnosti nacionalnih poslovnih sistemov in ki lahko vzpostavijo okolje za privabljanje inovacijskih dejavnosti. Takšno okolje omogoča rast lokalnih podjetij (zlasti malih in srednje velikih podjetij), saj pospešuje lokalno pozicioniranje industrijskega znanja in inovacijskih procesov.

V tej raziskavi sem razvil nabor treh hipotez o vplivu različnih politik na inovacijski uspeh in jih testiral z uporabo kvantitativne primerjalne analize mehkih množic na naboru podatkov 11 področij politik v 30 razvitih državah. Rezultati kažejo, da obstaja veliko različnih poti do

inovacijske uspešnosti. Formalno je inovacijska uspešnost sicer mogoča tudi brez intervencije javnih politik, saj niti 'ožje' niti 'širše' politike niso bile potrjene kot potrebni ali kot zadostni pogoj za inovacijsko uspešnost pri vseh poteh do inovacijske uspešnosti. Vendar pa obstaja veliko več poti, ki vodijo do inovacijske uspešnosti z različnimi oblikami javnih intervencij, tako v obliki 'ožjih' kot tudi 'širših' inovacijskih politik. Države, ki si prizadevajo za inovacijsko uspešnost, naj zato razmislijo o razvoju specifičnih inovacijskih politik na obeh področjih.

Z raziskovanjem odprte inovativnosti in njenih učinkov na strategije rasti malih in srednje velikih podjetij je disertacija pokazala, da ta koncpet koristi raziskovanju inovativnosti. Prav tako prispeva k izboljšanju inovacijskih aktivnosti v podjetjih vseh velikosti, saj jim pokaže, kako lahko izkoristijo inovacijski potencial izven meja svojih podjetij. V tej disertaciji je predstavljeno, kako lahko mala in srednje velika podjetja izboljšajo komercializacijo inovacij (in posledično rast podjetja), predstavljen pa je tudi jasno predstavljen mehanizem aktivnosti (vpliv preko inovativnosti).

Koncept odprtih inovacij ima tudi jasen vpliv na inovacijske politike. V času globalizacije inovacij in konkurenčnih inovacijskih ekosistemov nacionalne inovacijske politike igrajo pomembno vlogo pri vzpostavitvi pogojev, s katerimi lahko podjetja izkoristijo priložnosti, ki jih ponujajo spremembe v globalnem organiziranju inovacijskih aktivnosti. Ključ do hitrejše rasti inovativnih malih in srednje velikih podjetij ne leži samo v odpiranju samih podjetij, ampak tudi pri vzpostavljanju učinkovitih inovacijskih politik in privlačnih inovacijskih okolij, ki bodo olajšala inovativnost in s tem omogočila podjetjem vključitev v prihodnje verige vrednosti.

Ključne besede: inovativnost, inovacije, odprte inovacije, opdrti inovacijski sistemi, mala in srednje velika podjetja, kvalitativna primerjalna analiza (QCA) , inovacijske politike

SUMMARY

Innovation has become globalised and open in a way unimaginable even 20 years ago (Wooldridge, 2010). Companies now innovate in an environment in which competition is global, knowledge is spread more widely, R&D investments are increasing and product life cycles are shortening (Koen De Backer, Cervantes, Van De Velde, & Martinez, 2008). These changes have influenced new innovation research, with most interest recently being devoted to the new innovation concept of open innovation (Chesbrough, 2003). The open innovation concept presumes that companies use external ideas besides those generated inside the boundaries of the company. They also seek internal and external ways to the market for them. Research and development represent an open system (Chesbrough & Crowther, 2006).

The main overall research purpose of my dissertation is to research open innovation. My first research goal of this dissertation is to present the intellectual structure of the open innovation concept and its context in innovation research and innovation activities. In doing so in Chapter 1, my aim is to discover whether open innovation helps fill the gaps in our understanding of innovation. I conclude that open innovation is a distinct innovation concept that is here to stay. While it is not a true paradigm shift as it is sometimes claimed, it certainly does not constrain future innovation research as some critics have argued.

The concept has made significant contributions to innovation research. However, it also shows that more contributions can be expected in a few specific areas that represent clear gaps in open innovation research. The economic effects of open innovation are not well researched and related empirical studies remain scarce. In particular, small- and medium-sized enterprises are under-researched. The organisation of innovation communities and the establishment of public policies to both support and benefit from open innovation also deserve more attention.

The results of this broad research represent the foundation for the subsequent targeted research in specific and narrowly defined research areas. In Chapter 2, I focus on the business application of open innovation practices in small- and medium-sized enterprises. While conducting an empirical study based on newly collected survey data on the open innovation activities of 105 high-tech small- and medium-sized enterprises, I construct a working structural equation model of the antecedents of the commercialisation enablers of high-tech small- and medium-sized enterprises. The results confirm that there is a strong and positive link between innovativeness and commercialisation enablers in high-tech small- and medium-sized enterprises.

The main contribution of this research lies in testing how two specific open innovation practices impact the commercialisation enablers of high-tech small- and medium-sized enterprises through their innovation activities and innovativeness. The results show that

such enterprises which engage in broader types of open collaboration display higher levels of innovativeness which also leads to a greater propensity for commercialisation, hopefully leading to their faster growth.

In Chapters 3 and 4 I focus on the innovation policy implications of open innovation. In Chapter 3, I show that innovation policy research can benefit from utilising new research methods as they might lead to different policy recommendations. Focusing my attention on linkages and entrepreneurship, namely two sets of innovation activities essential to open innovation, I test how necessary they are for national innovation success. The research in this chapter demonstrates this by using a novel set-theoretic method called fuzzy set qualitative comparative analysis to analyse the data on innovation policies in the EU.

The result shows that the use of correlation-based statistical methods is inappropriate for evaluating innovation policies due to their causally complex nature that correlational methods are unable to unravel. Using the fuzzy set qualitative comparative analysis method, I show that linkages and entrepreneurship represent a necessary condition for innovation success and thus demonstrate the usefulness of the novel method for innovation policy research as well as for policymakers.

Having established the relevance of both the new research method and open innovation, I proceed to research different policies and their effects in Chapter 4. Due to the globalisation of innovation activities, I analyse not only the 'narrow' innovation policies (those that specifically target innovation measures) but also 'broader' policies. Broad innovation policies influence the characteristics of national business systems, thus aiming to establish an environment attractive to innovation activities. Such an environment facilitates the growth of local companies (especially small- and medium-sized enterprises) as it influences the local embedding of industrial knowledge development and innovation processes.

I develop a set of three hypotheses to test the role of different policies on innovation success and apply the set-theoretic method to a dataset of 11 policy areas in 30 developed countries to test them. The results show that several policy mixes lead to innovation success. Formally, innovation success can be achieved without successful government intervention and neither narrow nor broad innovation policies are necessary or sufficient for countries with innovation success. However, there are many more paths leading to innovation success with government intervention. Countries striving to become successful innovators should thus develop specific innovation policies in both areas.

In researching open innovation and its effects on the growth strategies of small- and medium-sized enterprises, this dissertation shows that open innovation has made a useful contribution to innovation research. It has also helped improve innovation activities in companies of all sizes by showing them how to harness the innovation potential outside the

boundaries of their firms. My dissertation shows that small- and medium-sized enterprises can improve the commercialisation of their innovation (and consequently growth) by utilising the insights offered by open innovation and outlines a clear mechanism of action (impact through innovativeness).

It also shows that open innovation has a clear influence on innovation policymaking. In an era of innovation globalisation and competing innovation ecosystems, national innovation policymaking plays an important role in establishing the conditions for companies to benefit from the changes in the global organisation of innovation activities. The key to the faster growth of innovative small- and medium-sized enterprises lies not only in them opening up, but also in providing efficient innovation policies and an attractive innovation environment that will facilitate their innovation activities and thus embed them in future value chains.

Keywords: inovativness, innovation, open innovation, open innovation systems, small and medium-sized enterprises, Qualitative Comparative Analysis (QCA), innovation policy

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

'Innovation doesn't happen in a vacuum. You're never alone. No one has the key just by himself.'
Rogier van der Heide, Chief Design Officer of Philips Lighting (2011)

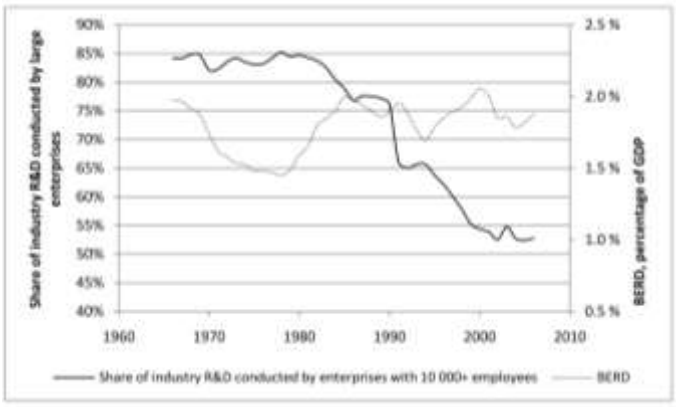
Description of the dissertation topic

Background and research context

Innovation is a phenomenon as old as mankind itself. There is something inherently 'human' about the tendency to think about new and better ways of doing things and to try them out in practice (Fagerberger, Mowery, & Nelson, 2006, p. 1). In spite of its obvious importance, it has not always received the scholarly attention that it deserves. Even though the 'father' of modern innovation research Joseph Schumpeter published his most important works in the 1930's, even as recently as the early 1960's, not many papers were published on innovation.

Research on innovation has since proliferated, especially in the social sciences. This increased interest in the research on innovation is based on the changes in innovation practices. The developments in recent decades have changed the prevalent innovation practices that have led to new theories of innovation, including open innovation. The context of this development was based on two major shifts in the economic environment: the expansion of innovation activities from large companies to other companies - decline of the Fordist regime of innovation organisation after the 1970's (presented in Figure 1 below) and the geographical expansion of innovation activities – globalisation.

Figure 1: The decline of Fordism in the United States



Note: BERD = Business enterprise expenditure on R&D
Source: Ebersberger et al.:
Open Innovation in Europe: effects, determinants and policy, p.27, 2011

These changes have brought new insights into research on innovation activities. Several theoretical concepts have emerged. Recently, the most attention has been devoted to a new concept of open innovation, that was introduced by Henry Chesbrough's 2003 book (Chesbrough, 2003). An open innovation system presumes that companies use external ideas besides those generated inside the boundaries of the company. They also seek internal and external ways to the market. Research and development represent an open system (Chesbrough & Crowther, 2006). It emphasises cooperation and sharing of ideas between companies regardless of the boundaries between the companies or states. Companies buy or license processes and innovations from other companies and at the same time push their innovations to the market through licensing, joint ventures or spin-offs (Chesbrough, 2003).

My research aim has been focused on a broad research field – researching open innovation – as well as specific and narrow research fields: business application of open innovation systems practices in small and medium sized companies (SMEs) and open innovation's implications on innovation policies. Using empirical data, I hope to contribute evidence in a field that has been relatively empirically underdeveloped. From this research, I've submitted three papers into reputable journals that will hopefully impact the narrow fields of interest and contribute to the body of knowledge on new innovation concepts.

In order to build a conceptual framework of open innovation before proposing specific research goals, I started with the critical review of the literature on open innovation that examines the state-of-the-art of the concept. Since the open innovation paradigm is relatively new, I expanded the review to the similar concepts of networked innovation, 'ecosystems' of companies, distributed innovation and others. Due to the relevance to innovation policy research, I've added to the literature review an overview of national innovation policies and policies supporting the implementation of open innovation systems. The goal was to provide a broader picture of the open innovation concept and to show promising fields for further research based on the open innovation concept.

My first research goal of this dissertation is to *present the intellectual structure of open innovation and its context in innovation research and innovation activities.* This broad objective will be researched in Chapter 1 by attempting to provide answers to two specific research questions:

Research question 1: *What is the intellectual structure of open innovation and other innovation concepts?*

Research question 2: *Did open innovation contribute to filling the gaps in understanding innovation?*

The results of this broad research will represent the foundation for the subsequent targeted research in specific and narrowly defined research areas.

Research areas

Research areas will be separated into distinct chapters in the dissertation. They are also closely linked to the three papers submitted for peer review. They are presented in the following sections.

1. **Business application of open innovation in SMEs**

Open innovation is not limited to large companies or specific industries (van De Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009). The number of smaller companies implementing open innovation activities is increasing. Nevertheless, the usage of open innovation activities in small and medium sized companies (SME's) remains an area that has not been sufficiently researched and is one of the knowledge gaps in the growing open innovation research field (Gassmann, Enkel, & Chesbrough, 2010).

Strategic implementation of open innovation systems is becoming the main research area of innovation research and an important field of business research. Considerable recent attention has been focused on the process of implementing open innovation systems in companies. While the first phase of business research discussed the effect of open innovation on the transformation of particular industries (J. Christensen, Olesen, & Kjar, 2005; Sarkar & Costa, 2008) or companies (Chiaroni, Chiesa, & Frattini, 2009; Di Gangi & Wasko, 2009), recent scientific contributions delved into more complex studies based on empirical data (van De Vrande et al., 2009). Even though empirical studies (especially about SME's) remain rare, there is an increasing amount of research on the business application of open innovation systems. They are aimed at answering questions like: 'How do you organise a company so that it can exploit the benefits of open innovation?' (Wallin & Von Krogh, 2010). A similar research question is also a focus of considerable debate – how to increase the absorption capacity for open innovation systems (Spithoven, Clarysse, & Knockaert, 2010). Some proponents of the open innovation paradigm even claim that it can help companies survive the crisis (Chesbrough & Garman, 2009).

In the first decade of open innovation research, its implementation was mainly studied in large companies. Many large corporations have come to the conclusion that in order to succeed in the 21st century, they need to join forces with other companies – or even individual researchers – and build innovation networks (Chesbrough, 2006). Some authors believe that the majority of Fortune 100 companies already use open innovation systems (DeSouza, 2010). U.S. companies that use open innovation include Intel, Microsoft, Boeing and others. There are also many interesting examples in the EU – such as Deutsche Telekom, BT or Philips. With the implementation of open innovation practices these

companies have enhanced their innovation capabilities. They have opened their traditional R&D processes in order to obtain creativity and knowledge (Rohrbeck, Hoelzle, & Gemünden, 2009).

Differences between 'old', 'closed' or 'Chandlerian' innovation systems and new, open innovation systems are important and are targeted by an increasing amount of research (Chesbrough, Vanhaverbeke, & West, 2006). The question of differences between open innovation systems in large corporations and SME's is an interesting field of research since it corresponds with two types of open innovation: the outside-in and inside-out type. Both types of open innovation influence the differences between large corporations and SME's. On the other hand, the implementation of open innovation systems in companies of all sizes depends on the openness of their business model and their business strategy (Chesbrough, 2006).

With a growing body of knowledge on open innovation, more specific research questions and topics are coming into focus. Open innovation in SMEs is one such topic. How SME's can utilize existing internal innovation and take it to the market (inside–out) is one example of a narrow research area within this concept. This is a research topic that is often described as commercialization. Specifically, well-positioned companies for research are high tech SME companies since they are more research oriented than other companies by definition. However, this has not been the target of much empirical research due to the lack of empirical data. In this dissertation, I will build upon a survey among high-tech companies in Slovenia to obtain empirical evidence on the open innovation practices that they use to support growth by improving their innovativeness and commercialization.

The research goals of my dissertation, connected to business application of open innovation in SMEs are thus to develop a conceptual model of how the increased usage of open innovation practices influences SME's, especially their growth strategies and to analyse the usage and trends in open innovation activities among the surveyed SME companies.

In Chapter 2, I aim to reach these goals by focusing on providing answers to two research questions:

Research question 3: *What are the specific antecedents of high-tech SMEs' commercialization enablers?*

Research question 4: *How do two specific open innovation practices (open innovation information exchange and open innovation collaboration) impact high-tech SMEs' commercialization enablers through their innovation activities and innovativeness?*

This dissertation aims to contribute to both business applications of open innovation and to empirical research of its usage in SME's. In Chapter 2, I will develop a set of hypothesis describing a conceptual model of the antecedents of commercialization enablers of high-tech SMEs. Using the statistical method of structural equation modelling (SEM), I will be able to test them and to contribute to filling the gap in the scientific understanding of business application of open innovation in SMEs.

2. New innovation policy implications and new methods to research them

The implications of open innovation systems on innovation policies have been predicted and studied since the definition of the concept. The main research question that it is trying to answer is: 'How can policy-makers make the business environment attractive to companies that implement open innovation practices?' Perhaps the most thorough research on the subject was produced by De Backer and his associates at OECD Science and Technology Directorate (2008).

Their findings confirm the view that in the global supply of science and technology, large corporations are increasingly creating their own ecosystems spreading across several countries. These global innovation networks incorporate individual researchers, research institutions (universities, government agencies…) and other companies in several countries. They also represent an opportunity for SMEs that can use them to expand internationally, becoming small multinational companies that are well integrated in global value chains. The aim of the cooperation is to solve particular problems, knowledge transfer and creation of new ideas. These global innovation networks have their own R&D capabilities as well as cooperation agreements with outside partners and suppliers. In these networks, companies are dependent on knowledge from partners (De Backer, López-Bassols, & Martinez, 2008). These ecosystems and innovation networks are creating international hubs that connect regional and national innovation systems. As a result, the boundaries of national innovation policies are increasingly blurred. New innovation policies need to be put into an international context from the beginning – as Saxenian and Sable argue in their critical evaluation of Finnish innovation policies (Saxenian & Sable, 2008). It is crucial that they focus on innovation collaboration and national innovation policies supporting the embedding of innovation activities in a new, global and open networked innovation system in the national environment.

However, new innovation concepts also influence the need to develop new methods for innovation policy research. Innovation policy studies have mainly used traditional statistical research methods for testing their hypotheses. However, the use of correlation-based statistical methods is not appropriate for testing due to the causally complex nature of innovation policies. There is strong evidence that methods such as set-theoretic methods could be more suitable (Schneider & Wagemann, 2012, p. 89). There are several reasons why this method is more appropriate for analysing causally complex phenomena like

innovation policies than standard, correlation based statistical methods. I believe that using this method on the topic of open innovation's effects on innovation policies will demonstrate that even innovation research can benefit from using innovative solutions. In Chapter 3, I will demonstrate the use of a typical set-theoretic method called fuzzy-set qualitative comparative analysis (fsQCA) for evaluating innovation policy measures, especially the importance of linkages & entrepreneurship for innovation policy success.

The research goal of my dissertation, connected to innovation policies in support of innovation collaboration is, therefore, *to demonstrate new methodological tools for researching innovation policies – specifically a fuzzy set (fsQCA) analysis on the national innovation policies in the EU.*

I intend to reach this goal by focusing on providing answers to two research questions in Chapter 3:

Research question 5: *Can new methodological tools bring new insights into innovation policy research?*

Research question 6: *Do linkages among actors and innovation commercialisation through entrepreneurship represent a necessary condition for innovation success (and thus require government intervention to overcome systemic failure)?*

National innovation policies have already started to adjust to the changes. Some successful examples include the European Union's policy instruments (Commission, 2013c), Taiwan (Lin, Shen, & Chou, 2010a) and those being discussed in the USA (Technology, 2010). It is also clear that open innovation policies influence internationalisation (Jacobs, 1998). By contrast, innovation policies that do not adjust to open innovation will not be successful (Švarc, 2006).

This change also influences structural policies in broader areas than is usually perceived – for example in the labour market, high-skilled labour force, competitiveness and innovation infrastructure spending. Public support for basic research in universities and public research institutions, ease of knowledge transfers, intellectual property protection and sharing, construction of a broad knowledge base and support to 'innovation culture' are crucial to successfully implement open innovation policies (Backer, Cervantes, Van De Velde, & Martinez, 2008).Innovation policies that support open innovation will likely have to develop new institutions or at least change the content of the existing institutions. They will need to improve the synergies between industries and the government. However, adjusting institutions alone will not support changes. Other socio-political systems also have the capability to influence open innovation adoption and thus represent a growth opportunity for SME's. Enabling the welfare state is a potential conceptual reference for further research of such policies (Kristensen, Lilja, Moen, & Jaklic, 2009). However, even

these systems can be improved. Good examples are 'bottom-up' initiatives. There is a clear public interest to support the development of open, innovative and growing SME's since they will support the enabling welfare state in their later stages of development. Innovative SME's have the potential to transform national economies and benefit from the increasingly open and global innovation activities. The transformation towards open innovation systems represents a challenge and an opportunity for SMEs and for policy-makers since they can use them to boost their growth.

Therefore, my research goal in this dissertation is also *to analyse different national innovation policy measures in support of open innovation and to show the national policy mix that is best suited for innovation success.*

I aim to reach this goal by providing answers to two additional research questions in Chapter 4:

Research question 7: *How can different innovation policies influence actors in the national innovation systems and influence their solving of the complex organisational problems that are involved in the transformation towards more open modes of innovating?*

Research question 8: *Is there a difference between traditional, 'narrow' innovation policies, and other, 'broad' policies that could also influence the local embedding of industrial knowledge development and innovation processes and its global value chain positioning?*

Research goals, research questions and operationalization of research methods

Table 1: An overview of research goals, research questions and research methods in the dissertation

	Research goals	Research questions	Research methods
Chapter 1 - **Intellectual structure of the open innovation field: critical literature review and bibliometric analysis**	1. To present the intellectual structure of open innovation and its context in innovation research and innovation activities	1. What is the intellectual structure of open innovation and other innovation concepts? 2. Did open innovation contribute to filling the gaps in understanding innovation?	Literature review Bibliometric methods
Chapter 2 - **Antecedents of high-tech SMEs' commercialization enablers: Opening the black box of open innovation practices**	2. Develop a conceptual model of how increased usage of open innovation practices influences SME's, especially their growth strategies 3. Analysis of usage and trends in open innovation activities among the surveyed SME companies	3. What are the specific antecedents of high-tech SMEs' commercialization enablers? 4. How do two specific open innovation practices (open innovation information exchange and open innovation collaboration) impact high-tech SMEs' commercialization enablers through their innovation activities and innovativeness ?	Structural equation modelling (SEM)
Chapter 3 - **National innovation policies in the European Union: a fuzzy-set analysis**	4. To demonstrate new methodological tools for researching innovation policies – specifically a fuzzy set (fsQCA) analysis on the national innovation policies in the EU;	5. Can new methodological tools bring new insights into innovation policy research? 6. Do linkages among actors and innovation commercialisation through entrepreneurship represent a necessary condition for innovation success?	fsQCA
Chapter 4 - **Government intervention in support of open innovation: national policy mix best suited for innovation success**	5. To analyse different government intervention policy measures in support of open innovation and to show national policy mix best suited for innovation success	7. How can different innovation policies influence actors in the national innovation systems and influence their solving of the complex organisational problems involved in the transformation towards more open modes of innovating? 8. Is there a difference between traditional, 'narrow' innovation policies, and other, 'broad' policies that could also influence the local embedding of industrial knowledge development and innovation processes?	Two-step fsQCA

The structure of the dissertation

As previously explained, the aim of my research is to explore the effects of open innovation on three specific topics: small and medium sized enterprises (SME's), innovation policies and new research methods to analyse them. The dissertation is thus composed of four major chapters.

Chapter 1 serves as a literature review that deals with an overview of the development of open innovation concept. It explores the historical development of open innovation using the bibliometric analysis, looks into the innovation practices that have spurred the open innovation concept and other novel innovation concepts. It puts open innovation into the context of innovation research by conducting a co-citation analysis. Finally, it looks into the contributions of open innovation to the theory of the firm, cluster theory and its implications on innovation policies and other issues.

Chapter 2 focuses on the business application of open innovation. It uses empirical data from a high-tech SME survey to develop a structural equation model (SEM) for selected antecedents of commercialization enablers. It looks at several open innovation constructs but focuses on its influence on commercialization. Its results show that there is an important role of open innovation collaboration in influencing SME's innovativeness and a high impact of their innovativeness on commercialization enablers. This implicitly supports the notion that open innovation influences their market orientation and thus growth even though the sample here is too small to support it directly. The results do support the usefulness of open innovation practices for SME's for both their innovativeness and their commercialization orientation. They also show the prevalence and usage of open innovation practices in Slovenian SME's.

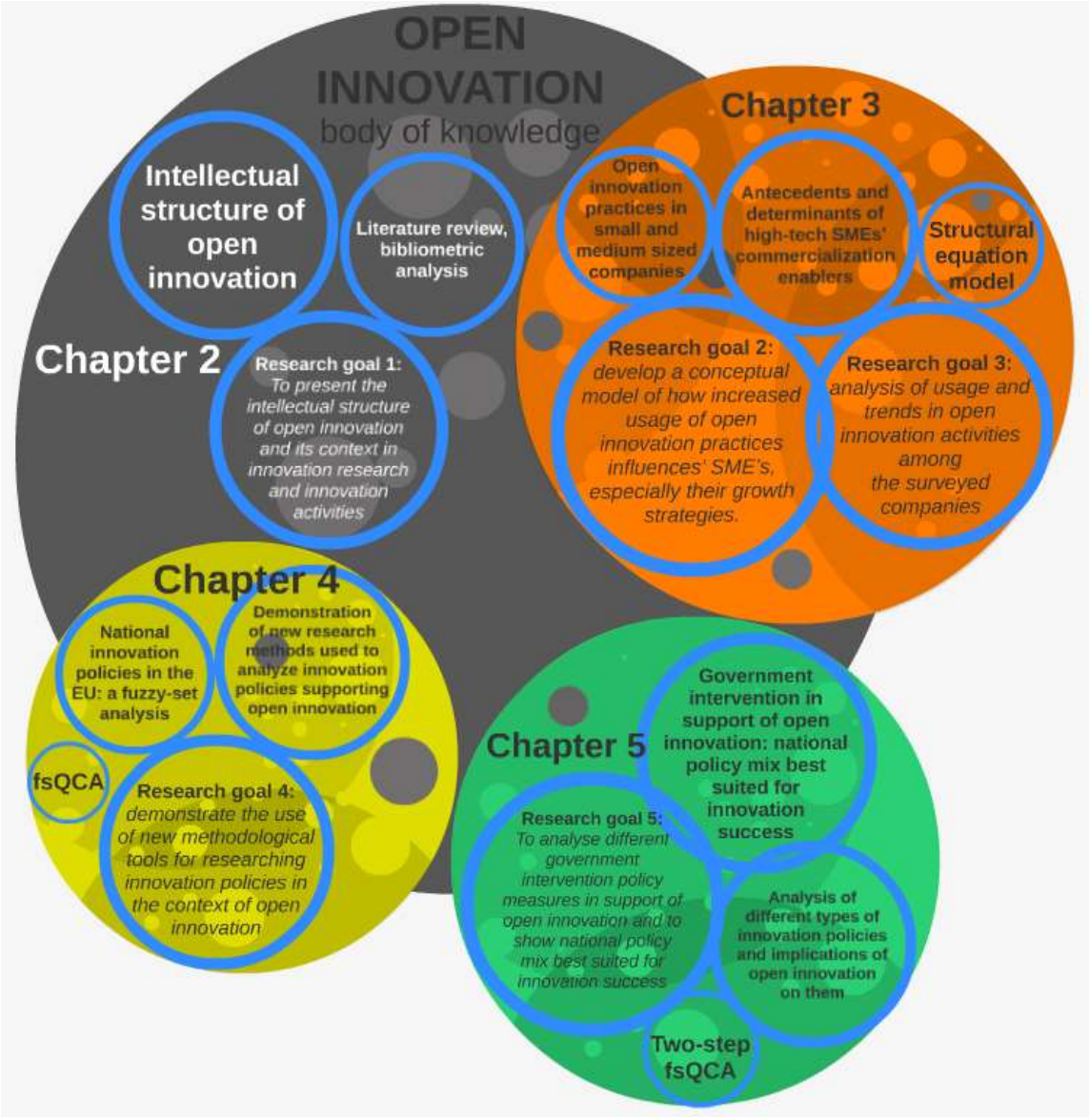
Chapter 3 shows that open innovation policy research can benefit from utilizing new research methods since they might lead to different policy recommendations. It compares standard correlation-based statistical methods with set-theoretic methods that are rarely used in policy research. New methods are demonstrated in an analysis of the European Union's innovation polices that include policies aimed at supporting open innovation. It shows the special importance of linkages among actors and innovation commercialization through entrepreneurship and proves that they represent a necessary condition for innovation success. The quantitative comparative analysis method also allowed me to define similarities and differences between countries and recognize examples of good practices in innovation policy-making.

Chapter 4 uses this new research method to analyse the implications of open innovation on innovation polices. It differentiates between 'narrow' innovation policies and 'broad' policies that support open innovation. The results show that while none of the individual innovation policies tested is either necessary or sufficient for innovation success, policy

makers would still be advised to try to develop national innovation policies. It shows that new developments are influencing the transition into more open modes of innovation and that policy intervention is a safer bet for governments trying to prepare for them. It also shows that national innovation policies remain the essential element of national development policies. Open innovation does not make policy intervention obsolete or redundant.

Although each chapter consists of an introduction and a conclusion, concluding remarks are made at the end of the dissertation followed by the list of references used. Finally, an extensive appendix describing the details of research methods used is provided for demonstration purposes for potential future research.

Figure 2: Dissertation framework



CHAPTER 1: INTELLECTUAL STRUCTURE OF THE OPEN INNOVATION FIELD: STATE OF THE ART AND A CRITICAL LITERATURE REVIEW

The nature of innovation has changed recently. Innovation activities have become globalized and open in a way that was unimaginable even 20 years ago (Wooldridge, 2010). Companies now innovate in an environment in which competition is global, knowledge is spread more widely, R&D investments are increasing and in which product life cycles are shortening (De Backer, Cervantes, Van De Velde, & Martinez, 2008). Companies can no longer succeed by developing the next innovative product in their internal laboratories or by outsourcing manufacturing activities to low-cost countries (Herrigel, 2010). Countries implement competing innovation policies in order to become more attractive as potential innovation hubs.

These changes have brought new insight into innovation research. Several theoretical concepts have emerged, but the most interest has recently been devoted to a new innovation concept of open innovation, introduced by Henry Chesbrough's 2003 book (Chesbrough, 2003). The open innovation concept presumes that companies use external ideas besides those generated inside the boundaries of the company. They also seek internal and external ways to the market for them. Research and development represent an open system (Chesbrough & Crowther, 2006)[1].

Chesbrough claims that open innovation represents a paradigm shift. It emphasises cooperation and sharing of ideas between companies regardless of the boundaries between companies or states. Companies buy or license processes and innovations from other companies and at the same time push their innovations to the market through licensing, joint ventures or spin-offs (Chesbrough, 2003). This challenges the 'closed' innovation model that sees innovation as the result of work of the large internal laboratories that only large, usually multinational companies can afford.

While no one disputes that the open innovation concept has attracted a lot of attention both in practice and academia (Huizingh, 2011), there are authors that claim it is not a clear concept and that it comes in many forms, which makes the concept rich but hinders generalization. Others dispute the paradigm shift that open innovation claims to present. They predict that the term will fade away in a decade (Huizingh, Conn, & Torkkeli, 2011), merging into the 'standard' definition of innovation. Others have suggested that the term

[1] In the dissertation, I continue to use Chesbrough's definition of open innovation which he defines as: "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively" (Chesbrough et al., 2006, p. 1).

itself could be acting as a communication barrier - hindering growth in research and understanding, thus representing constraint to future research (Groen & Linton, 2010).

How can there be such different views on such a widely used concept? The aim of this chapter is to research the open innovation concept. I will try to provide answers to the following three questions:

1. Is open innovation really a new paradigm in innovation research as stated by Chesbrough (2003) ?

2. Is the open innovation concept a distinct concept or one that will fade away in a decade and merge into the 'standard' definition of innovation as claimed by Huizingh et al. (2011) ?

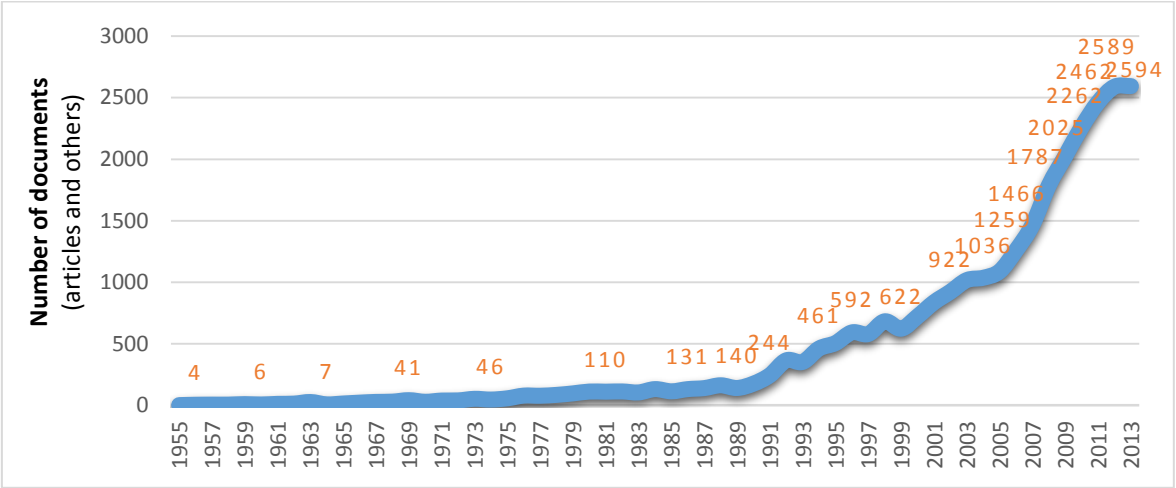
3. Is open innovation actually hindering growth in research and understanding innovation and representing a constraint to future research (Groen & Linton, 2010)?

At the end of the chapter, I intend to position open innovation in the context of innovation research and to show the areas where open innovation has already contributed to our understanding of innovation. I would also like to identify areas where future research can contribute to the concept of both open innovation and to our general understanding of innovation. By doing so, I want to add a small contribution to our understanding of (open) innovation by providing additional insights in the following chapters. To do that, I first have to ask myself an overarching question – what do we currently know about innovation (and what don't we know yet)?

1.1 Innovation – a brief history of scholarly research

To answer this question, I have examined the history of scholarly attention to innovation. In spite of its obvious importance, it has not always received the scholarly attention it deserves. Even as recently as in early 1960's, not many papers were published on innovation. Those that were published were embedded in other fields of research. The 'father' of modern economic innovation, Joseph Schumpeter, was a social scientist with a keen interest in business cycles and in institutional change, using his focus on innovation as a factor of economic development.

Figure 3: Scholarly Articles with 'Innovation' in their topic, 1955-2013



Source: own calculation based on Thompson Reuters Web of knowledge 2014

This is now changing. Research on the role of innovation in economic and social change has proliferated in recent years, particularly in the social sciences, and with a bent towards cross-disciplinary approach (Fagerberger et al., 2006). For example, economics has dealt primarily with the allocation of resources to innovation and its economic effects while the innovation process itself has been researched by other disciplines, including management, sociology, and organizational and business studies.

The history of the development of innovation thought presented by Fagerberg (2005) shows that numerous authors have been able to contribute to answering several important questions on innovation:

Despite 50 years of innovation research, we know much less about why and how innovation occurs than what it leads to. Our understanding of how knowledge and innovation operates at the organizational level remains fragmentary and further conceptual and applied research is needed (Fagerberger, 2005).

Did open innovation contribute to filling the gaps in understanding innovation? To answer that, I first had to look at the historical development of open innovation and its contributions to understanding of innovation.

Table 2: An overview of the main contributions on innovation research

Research questions	Main contributions to innovation research	Main insights
What is innovation?	Several typologies were developed that focused on defining different types of innovation: a. New products, new methods of production, new sources of supply, exploitation of new markets, new ways to organize a business (Schumpeter, 1934) b. Innovation, Invention, Imitation (Benoit, 2008) c. Incremental and radical innovation (Freeman & Soete, 1997), disruptive innovation (Christensen & Raynor, 2003; Christensen, 2013) d. Linear vs. Non-linear innovation (Kline & Rosenberg, 1986) e. The context of innovation (for example 'technology transfer'). (Hobday, 2000)	The function of innovation is to introduce novelty (variety) into the economic sphere. With no innovation, the economy will settle into a state with little or no growth. Innovation is crucial for long-term economic growth. Many different types of innovation exist with distinct features that have influences on their research and implementation.
How does innovation occur? (with the insight on the systemic nature of innovation)	a. With individual efforts of entrepreneurs or within firms (Schumpeter, 1970; Schumpeter, 1934) b. How do companies innovate (Nelson & Winter, 1982) c. The dangers of path dependency (Arthur, 1994) d. The patterns of technological change (Pavitt, 1984) e. The importance of absorptive capacity (Cohen & Levinthal, 1990) f. 'Not-invented-here' symptom preventing innovation (Katz & Allen, 1982) g. National and regional systems of innovation (Lundvall, 1992; Nelson, 1993) h. Dangers of 'bottlenecks'- critical complementary components for innovation (Rosenberg, 1982)	A firm does not innovate in isolation but based on extensive interaction with its environment. Innovation journey is a collective achievement (Van de Ven, Polley, Garud, & Venkatarman, 1999). System and network perspective are useful for the study of innovation.
Clustering characteristics of innovation (in both time and space)	a. Why do innovation cluster and what kind of consequences does that have (Chandler, 1962; Nelson & Winter, 1982; P., 1979; Schumpeter, 1934) b. Implications of innovation clustering on business cycles (Marx, 2004; Schumpeter, 1934) c. Product life cycle theory (Vernon, 1966) d. Industrial dynamics (high-tech industries) (Pavitt, 1984) and technological regimes (Malerba & Orsenigo, 1997)	Innovation tends to cluster in certain industries, which consequently grow more rapidly, implying structural changes in production and demand and, eventually organizational and institutional change. It also clusters in time, influencing business cycles.
Effects of innovation on economic performance	a. What kind of effect does innovation have on growth (Mensch, 1979; Perez, 1983) b. Relationship between technological, organizational and institutional change (Freeman, 1987) c. Differences in economic growth between countries (Posner, 1961)and the technology gap (Fagerberg, 1994)	Innovation is a powerful explanatory factor of differences in performance between firms, regions and countries. Innovative countries have higher productivity and income then less innovative ones.

1.2 Historical development of open innovation concept

The beginning of the open innovation concept is clear – , it was introduced in Henry Chesbrough's book in 2003 (Chesbrough, 2003). It received significant interest from scholars who soon followed with a growing number of publications. The initial studies of open innovation focused on early adopters and good practice examples, which tend to be successful. They were usually case studies and descriptive in nature e.g. (Chiaroni et al., 2009; Christensen et al., 2005; Huston & Sakkab, 2006). Most case studies also focused on particular industries, most often high-tech (Chesbrough, 2003).

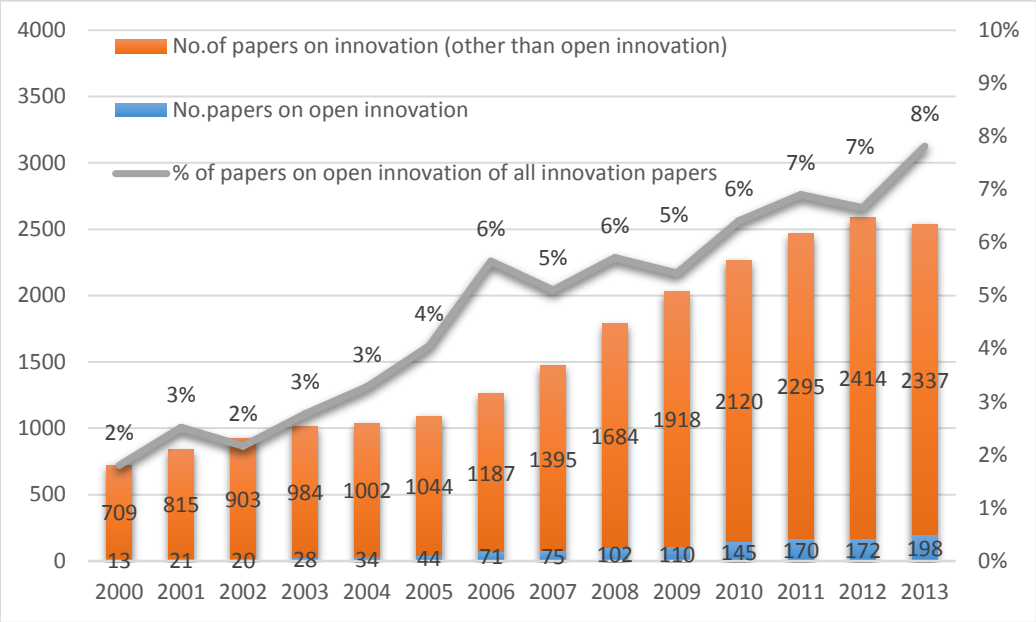
These initial studies were followed by expanding the scope to other industries (Chesbrough & Crowther, 2006). Some authors soon discovered that 'few corporations have institutionalised open innovation practices in ways that have enabled substantial growth or industry leadership' (Rufat-Latre, Muller, & Jones, 2010). More case studies followed that attempted to compare different open innovation practices to determine their context dependency e.g.(Sarkar & Costa, 2008), (Vanhaverbeke, Ine, & De Zutter, 2012). They expanded the scope of activities connected to the concept (Grøtnes, 2009).

At the same time, the first empirical studies were implemented. They initially used existing data sources like the European CIS survey (Ebersberger, Herstad, Iversen, Kirner, & Som, 2011; Mention, 2011) or global indicators that were not designed to measure open innovation (De Backer et al., 2008). They later included specific quantitative studies, but often focused on certain industries (Harison & Koski, 2010), countries (Lazzarotti, Manzini, & Pellegrini, 2010) or institutions (Spithoven et al., 2010).

Some quantitative studies focused on small and medium sized companies and discovered that open innovation is a logical step for them. Consequently, they are collaborating with external partners more frequently than large companies (van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009). Others discovered that open innovation is not always the best option (Knudsen & Mortensen, 2011). A 'closed' innovation system can also be more suitable for some companies or even industries, as there are clear differences in open innovation among companies and industries. Some authors even believe that 'closed' innovation systems could return and see evidence of that emerging with the development of the Internet (Anderson & Wolff, 2010). A growing body of knowledge on open innovation has brought new insights into open innovation activities that might influence the definition of the concept. Even though the name of the concept itself was questioned (Badawy, 2011), the consequent debate did not influence the growing appeal of the open innovation concept under its original name. When compared with the similar concepts presented above, it remains the most used and popular among scholars. Many researchers find open innovation to be a useful concept that explains the current developments in innovation activities.

Similarly, many companies started intentionally developing their innovation activities in a more open way. Some authors believe that the majority of Fortune 100 companies already use open innovation systems (DeSouza, 2010). However, this might represent a potentially troublesome development – an increased use of open innovation practices by practitioners but stagnation in the number of scholarly contributions.

Figure 4: Share of scholarly articles on 'Open innovation' among those on 'Innovation', 2000-2013



Source: Own calculation based on Thompson Reuters Web of knowledge 2014

This figure shows that even though the concept of open innovation is increasingly popular, it is not a well-researched field. The number of publications is growing but is still rather limited. Even more importantly, there are only a handful of empirical studies. Most empirical studies have also focussed on a small sample of cases, concentrated within high-tech-industries, and have addressed only a few countries, in particular, the US. The wide distribution of research areas on open innovation is clearly reflected in the topics that are covered by the most cited open innovation papers.

1.3 Bibliometric analysis of open innovation

Analysing the interest in open innovation, the search of Thomson Reuters Web of Science for "open innovation" in the topic of documents and limiting the results to management, business and economics categories and to articles (including books) resulted in 1.251 documents remaining in the final document set. If I exclude the documents on open

innovation from before 2003 (when open innovation concept was introduced), I have a dataset of 1089 articles[2]. The most cited research articles are presented in the table below.

Table 3: Top 10 open innovation research publications in the core document set

Authors	Title	Year	Source Title	Total Citations
Laursen, Salter	Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms	2006	STRATEGIC MANAGEMENT JOURNAL	514
Owen-Smith, Powell	Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community	2004	ORGANIZATION SCIENCE	408
von Hippel, Evon Krogh	Open source software and the private-collective innovation model: Issues for organization science	2003	ORGANIZATION SCIENCE	362
Chesbrough	The era of open innovation	2006	MIT SLOAN MANAGEMENT REVIEW	334
Lakhani, von Hippel	How open source software works: free user-to-user assistance	2003	RESEARCH POLICY	321
Adams, Hurd, McFadden, Merrill, Ribeiro	Healthy, wealthy, and wise? Tests for direct causal paths between health and socioeconomic status	2003	JOURNAL OF ECONOMETRICS	174
Oxley, Sampson	The scope and governance of international R&D alliances	2004	STRATEGIC MANAGEMENT JOURNAL	172
Chesbrough, Crowther	Beyond high tech: early adopters of open innovation in other industries	2006	R & D MANAGEMENT	168
Lee, Cole	From a firm-based to a community-based model of knowledge creation: The case of the Linux kernel development	2003	ORGANIZATION SCIENCE	166
von Krogh, Spaeth, Lakhani	Community, joining, and specialization in open source software innovation: a case study	2003	RESEARCH POLICY	166

Source: Thompson Reuters Web of knowledge 2014

[2] An interesting recent development in open innovation research has been the allegations against the single most prolific scholar on open innovation, Ulrich Lichtenthaler, who has published 27 articles on open innovation listed in the Web of Science (out of almost 50, some of them highly cited). After alleged deficits in his publications, an expert group found severe mistakes in his work including a diverging interpretation of the same data set in different publications and severe statistical mistakes. As a result, at least 13 articles have been retracted and his teaching certificate has been revoked (West, 2013). The shows that the open innovation community is not shielded from scientific wrongdoing, but also that the community and the peer review system are sufficiently robust to detect it.
In this analysis, I have kept all the articles that remain in the Web of knowledge.

This analysis shows that open innovation remains most widely used in the management of R&D. This is clearly seen from the top journals publishing open innovation research with four out of five top journals that publish open innovation research focusing on R&D management. However, many other areas also show that open innovation is useful beyond innovation (and R&D) management research.

Table 4: Top journals that publish open innovation research, sorted by number of open innovation articles published

Source Titles	Published articles
RESEARCH POLICY	78
R D MANAGEMENT	60
INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	53
TECHNOVATION	38
RESEARCH TECHNOLOGY MANAGEMENT	37
JOURNAL OF PRODUCT INNOVATION MANAGEMENT	35
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	33
TECHNOLOGY ANALYSIS STRATEGIC MANAGEMENT	29
ORGANIZATION SCIENCE	20
CALIFORNIA MANAGEMENT REVIEW	19
INNOVATION MANAGEMENT POLICY PRACTICE	19
MANAGEMENT SCIENCE	19
MANAGEMENT DECISION	16
INDUSTRY AND INNOVATION	15
CREATIVITY AND INNOVATION MANAGEMENT	14
HARVARD BUSINESS REVIEW	14

Source: Thompson Reuters Web of knowledge 2014

Interestingly, in the most extensive literature review performed up to 2010 (Dahlander & Gann, 2010), the authors include papers on open innovation that were published even before the concept was introduced in 2003. They also present some additional findings. First, open innovation is not a completely new concept as the organisation of innovation activities that breached firm boundaries was already present before the introduction of the open innovation concept. This includes distributive innovation (Lakhani & Panetta, 2007) and network innovation (Steinle & Schiele, 2002) that remain closely connected to open innovation. The main difference between these concepts is the ratio between internal and external sources of innovation. Due to these similar concepts, the open innovation paradigm was much less sudden and more gradual. The open innovation concept that was introduced in 2003 was new, but open innovation activities were not. This can be clearly seen in the table below, where open innovation references are presented. A sizable percentage of open innovation research is clearly founded on previous innovation research.

Table 5: Top 15 most cited references by open innovation research core document set

Authors	Title	Year	Source Title	Total Citations
Chesbrough	Open innovation: The new imperative for creating and profiting from technology	2003	HARVARD BUSINESS PRESS	269
Cohen, Levinthal	Absorptive capacity: a new perspective on learning and innovation	1990	ADMINISTRATIVE SCIENCE QUARTERLY	241
Laursen, Salter	Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms	2006	STRATEGIC MANAGEMENT JOURNAL	157
von Hippel, von Krogh	Open source software and the private-collective innovation model: Issues for organization science	2003	ORGANIZATION SCIENCE	122
von Hippel	The sources of innovation	1988	SPRINGER	121
von Hippel	Democratizing innovation: The evolving phenomenon of user innovation	2005	SPRINGER	120
Lerner , Tirole	Some simple economics of open source	2002	THE JOURNAL OF INDUSTRIAL ECONOMICS	112
Teece	Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy	1986	RESEARCH POLICY	107
March	Exploration and exploitation in organizational learning	1991	ORGANIZATION SCIENCE	98
Nelson, Sidney	An evolutionary theory of economic change	1982	CAMBRIDGE: BELKNAP	97
Teece, Pisano, Shuen,	Dynamic capabilities and strategic management	1997	STRATEGIC MANAGEMENT JOURNAL	93
Powell, Koput, Smith-Doerr	Inter-organizational collaboration and the locus of innovation: networks of learning in biotechnology	1996	ADMINISTRTIVE SCIENCE QUARTERLY	91
Eisenhardt	Building theory from case study research	1989	ACADEMY OF MANAGEMENT REVIEW	89
Chesbrough	The era of open innovation	2003	SLOAN MANAGEMENT REVIEW	87
Chesbrough, Crowther	Beyond high tech: early adopters of open innovation in other industries	2006	R&D MANAGEMENT	86

Source: Thompson Reuters Web of knowledge 2014

While the concept is often presented as a revolutionary shift in understanding innovation activities, the change has been much less abrupt (Altmann & Li, 2011). In fact, open innovation is building on work developed by several innovation concepts introduced in the 1980's and 1990's

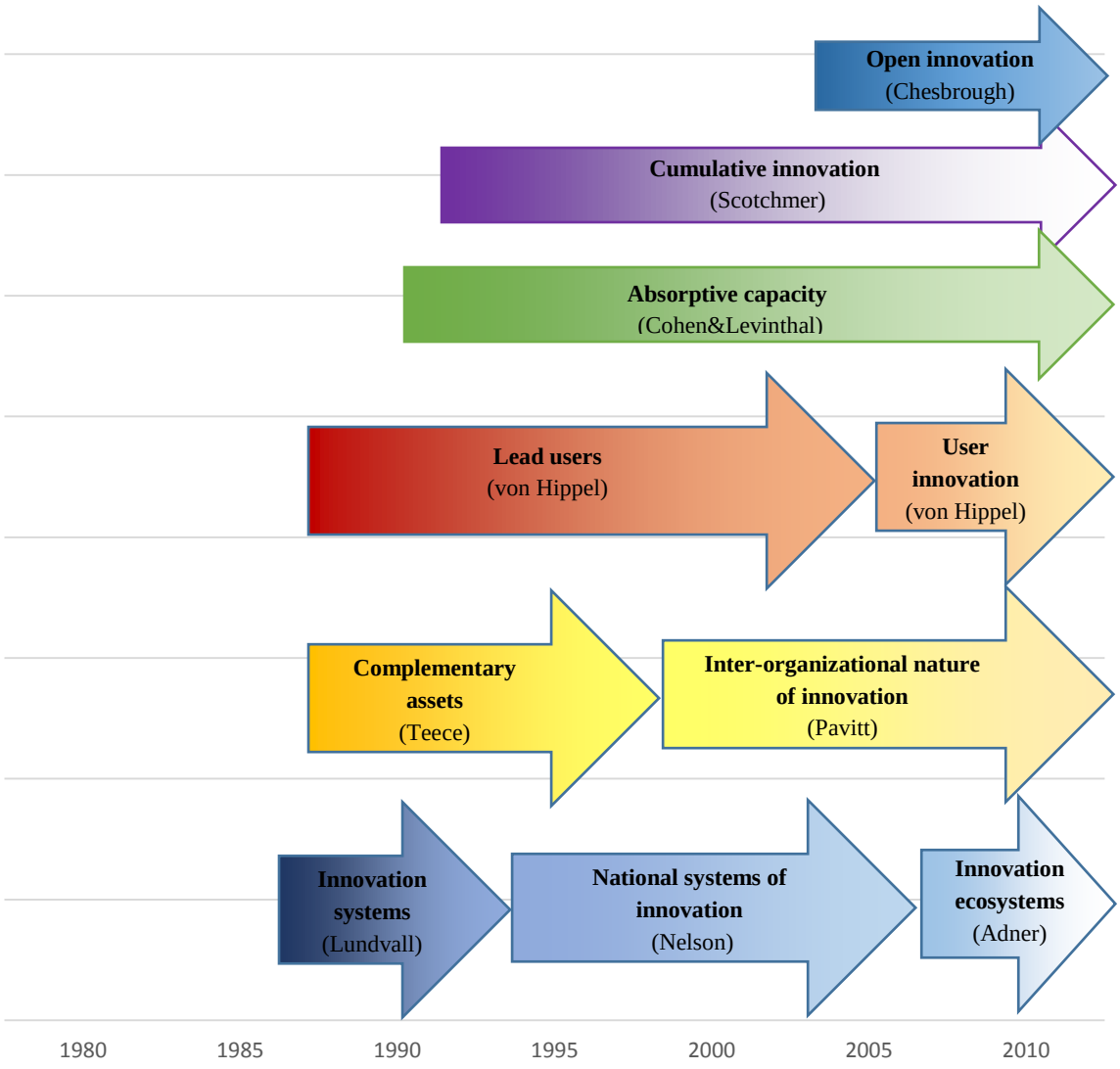
,

1.4 Development of the open innovation concept in innovation research

The concept of absorptive capacity supported the idea that companies should access and absorb external ideas, science and other kinds of knowledge inputs to innovation (Cohen & Levinthal, 1990). Complementary assets were discussed in regard to market failures in the innovation activities (Teece, 1986). The inter-organizational nature of innovation learning has been discussed by many authors (for example Pavitt, 1998). User-led innovation (von Hippel, 1986) introduced involvement of users in the innovation process. The concept of an 'innovation system' that includes customers, suppliers, competitors, universities, government organisations etc. was first used by Lundvall (Lundvall, 1985). The analysis of innovation systems was upgraded with the work of Nelson (Nelson, 1993) and others and is sometimes developed into innovation ecosystems (Adner, 2006). Exploration and exploitation of organisational learning were also discussed before (March, 1991).

Open innovation (as well as other authors before, for example Kline and Rosenberg (1986) also challenges the linear model of innovation (research → invention → innovation → diffusion) from the 1960's with the central role for research and development (Clark & Guy, 1998; Gibbons et al., 1997). These models never corresponded to the complexities of the innovation processes (Chesbrough, 2003, 2006) as they could not explain innovation activities of small and medium enterprises or clusters. Open and networked innovation systems are much better able to explain the competitive advantage of these organizations. New models look at innovations as a non-linear technical and social process based on complex relations between companies and their environment (Asheim & Isaksen, 1997). These models explain the innovation process from the viewpoint of innovation flows in the organisations and between them (Saxenian, 1994) as the companies cooperate with suppliers, customers, research institutes or even competitors.

Figure 5: A historical overview of development of innovation concepts



Dramatic developments of innovation activities and innovation research have not only influenced the emergence of the open innovation concept. Building on similar academic foundations, other innovation concepts have developed at the same time as open innovation.

Open innovation is often compared to open source innovation. Open-source innovation is a more specific concept, most often associated with software (Euchner, 2010). In open-source software, platforms like Linux represent platforms that enable users to develop and share the code that they need. There is no owned intellectual property since anyone can access, use and modify the code. That does not mean that there are no governance structures though and business models have developed based on the open-source. In fact, business model development based on open-source innovation has many similarities with open innovation and open business model generation. However, the concept of open –

source differs from open innovation in three main characteristics: intellectual property rights are open, open governance of R&D and open direction of development (Euchner, 2010).

The usage of open-source innovation is spreading from the IT industry to industries such as medical engineering and sports equipment. Some authors believe that there is a clear technological trend and that open-source community innovation will be the future of open innovation (Bughin, Chui, Johnson, & Internet, 2008). The new technological revolution of digital manufacturing could represent a great boost to open source (Pearce et al., 2010). Its recent applications include development of open-source communities for scientific publishing and design.

Nevertheless, there are signs that open-source innovation has reached its potential in software development (The Economist, 2012), an industry where it has become the most prevalent. Other open source usages have remained limited to a few cases and have failed to gain wider usage. As the open source concept is already well over a decade old, it has developed beyond expectations. However, it has not become the dominant or only innovation concept even in software development. Some argue that it will remain an interesting but niche practice of innovating (Economist, 2006).

Open source innovation is based on networks of individuals that form a community. This community both contributes to the development and uses the product or service. Sometimes, these networks have enabled users to radically redefine the role of the firms that supply them. Von Hippel sees this as a more general trend where users (both individuals and firms) are increasingly able to innovate for themselves (von Hippel, 2005). Similarly, the concept of user innovation builds on the insight of van Hippel that in many industries, users were the originators of the most novel innovation. The user's dominant role in originating innovations reflects the fact that knowledge is distributed and sticky, an insight originating from Hayek's work in 1945 (Hayek, 1945). The distributed nature of knowledge results in the acknowledgement that traditionally closed models of proprietary innovation will have difficulty completing knowledge intensive tasks when most of the needed knowledge resides outside of the organisation (Lakhani & Panetta, 2007). The user innovation concept represents several distributed innovation systems, including open source innovation. In practice, the limitations of such innovation are notable. They include a high failure rate for several projects, organisational issues in regards to delivering innovations on demand and difficulties in embracing distributed innovation into organisations. The last limitation is closely connected with the issues of trade secrecy and intellectual property protection (Lakhani & Panetta, 2007).

Even though open innovation and user innovation are closely connected concepts with a number of similarities and based on the same socio-economic and technological changes of the last decades, they are completely distinct and even competitive. Their main difference

is in the business model. User innovation focuses on value creation through lead users and innovation communities. Open innovation does not only focus on value capture. This is the distinction that has made it very popular with companies when they finally realize how they can profit from user innovation. Open innovation is primarily focused around the organization and the process of open innovation is within the firm and on ways of how to profit from them. Therefore, it clearly supports Intellectual Property Rights (IPR), while user innovation (especially open source innovation) does not support private ownership IPR. There are other differences between the user innovation concept and the open innovation concept, but it is clear that the main difference is the profit motive as the driver of innovation in the open innovation concept (West, 2012). Open and user innovation remain two separate, but similar theories of innovation.

In reality, both research streams are separate with only a handful of scholars active in both communities. Few authors have tried to combine and consolidate the two research streams. One example is Joel West (2010), who coined the overarching term of distributed innovation. However, the term has not yet been widely accepted.

There is a third body of scholarly research on innovation – cumulative innovation. This concept is most recently associated with the work of Scotchmer (1991). Her contribution from the 1990's and 2000's emphasises the cumulative nature of research since most new discoveries are the result of previous technological progress. They are based on the foundations provided by earlier researchers and innovators (Scotchmer, 1991). The cumulative nature of research poses challenges to the patent system. It does not provide proper incentives for research since it rewards only individual, often breakthrough innovations. By contrast, most improvements are incremental. The cumulative innovation literature considers the role of interdependencies of producers within the industry (West, 2009). Companies often share the leadership of technological progress, which does not depend on any one individual or firm. Companies also build upon a common, ever increasing pool of enabling science, even if their specific products are unique point products. The best example is the biopharmaceutical drug discovery (Scotchmer, 2004).

In some cases, cumulative innovation is fuelled by explicit cooperation between firms, while in other cases an industry's joint innovation is advanced through unintended spill-overs and information flows among the firms in the industry. In the latter case, cumulative innovation happens to the degree to which it is permitted by IP policies, as firms use whatever information is available to develop their innovations — and thus, IP monopolies tend to slow the rate of innovation and progress (Scotchmer, 1991). In contrast to the open innovation concept, cumulative innovation sees intellectual property protection as a possible hindrance to innovation.

There are other innovation concepts connected to similar innovation activities that form the foundation of the open innovation concept. Doing, using and interfacing mode of learning

and innovation emphasises the role of informal processes of learning and experience-based know how (Jensen, Johnson, Lorenz, & Lundvall, 2007).

1.5 Recent developments in innovation practices

The reason for the development of open innovation and other innovation concepts was the changing nature of innovation practices. During the first decades of the 20th century, industrial enterprises in the US cooperated and sourced R&D services from dedicated external R&D labs in a way that is very familiar to the current practitioners of open innovation (Huizingh, 2011; Mowery, 1983). The best known example is Edison's The Invention Factory at Menlo Park. Cooperation between companies was common at the time and critical to the survival of an industrial structure dominated by small firms (Hollingsworth, 1991).

With the rise of the Fordist regime of vertically integrated mass production, organisation of innovation activities changed. Innovation became the result of intramural R&D. This Fordist regime was consolidated after the Second World War when large corporations were able to lower the cost of innovation by organising it internally. They were able to streamline the innovation process and gain economies of scale and scope for their R&D (Henderson & Cockburn, 1996). However, these large internal R&D laboratories suffered from weak private returns due to massive production of spill-overs upon which venture capitalists and entrepreneurs where able to feed (Herstad, Bloch, Ebersberger, & van de Velde, 2010).

The US Fordist regime was severely challenged by the economic downturn of the 1970's that forced a stronger focus on shareholder's – private – returns (Jensen, 1993). In 1980's, it seemed as if the second industrial divide was unfolding that would reward smaller, networked and more flexible modes of innovation and production (Sabel & Piore, 1984).

In 1990's, the focus shifted to different innovation system approaches that emphasized knowledge diffusion and interactive learning as the basis for development. Similarly, organisation of R&D in companies has progressed from the 'first generation' R&D lab oriented organization to 'second generation' market-pull model to 'third generation mode' where internal R&D should be integrated with other knowledge communities internal and external to the corporate enterprise (Roussel, Saad, & Erickson, 1991).

As I have shown (and like in many other revolutionary shifts), the development of the open innovation concept was less revolutionary and more evolutionary than initially claimed. It became clear that open innovation activities were present and used a long time ago, were the target of scholarly interest and were not such a clear paradigm shift (Kuhn, 1962) as sometimes claimed. But has open innovation thus been redundant, yielding no contributions to scholarly research of innovation and perhaps just limited to being a useful

tool for companies that they can use to profit from innovation of others? Or has it made contributions to the theoretical understanding of innovation that other theories haven't been able to? Based on the literature review, I was able to emphasise at least three areas where open innovation has made contributions to the body of knowledge.

1.6 Contributions of Open Innovation

1.6.1 Contributions of Open Innovation to the theory of the firm

The result of the decline of the Fordist regime of innovation organisation and of the organisational expansion of innovation activities is that the locus of innovation is shifting away from the individual firm and national innovation system towards globally distributed knowledge networks. This development was not as new and surprising as it might seem. Alfred Marshal's concept of 'external economies' in 'industrial districts' were inspired by the modes of industrial organization found prior to the growth and consolidation of Fordism (Marshall, 1920). The major advantages of Marshallian industrial districts arise from the simple propinquity of firms, which allows easier recruitment of skilled labour and rapid exchanges of commercial and technical information through informal channels. They illustrate competitive capitalism at its most efficient, with transaction costs reduced to a practical minimum; but they are feasible only when economies of scale are limited.

However, the consequent theoretical work on the theory of the firm developed in another direction that implied that open innovation systems were opposing the existing economic theories of the firm. The debate on the nature of the firm followed Coase's insight that transaction costs in the market are not minimal but rather large. They represent a market failure that allows company's administrative control over transactions to be more efficient than market transactions (Coase, 1937). According to the transaction cost theory that evolved, companies exist since it is preferable not to leave some complex functions to the market as transaction costs would be too high (Williamson, 1975). Innovation services are an example of such a complex transaction, Therefore, according to this theory, open innovation systems would be less competitive than internal research.

Evolution theories (Nelson & Winter, 1982; Penrose, 1952, 1995; Veblen, 1898, 1899) describe development of companies from lower to higher levels of operations and success as a result of manager's actions, who transfer new routines to operational levels of the company. They are connected to the general theory of evolution, which can be understood as any process whereby small variations can accumulate and predominate over time into large-scale changes. Companies improve their efficiency with relentless repetitions. By transferring complex routines and functions beyond the boundaries of the firm it would lose crucial benefits and control that it derives from its ownership. I find them especially useful as the underlying foundation for the research of business ecosystems. In connection

to open innovation, they support government intervention as necessary due to the systemic failure argument. I will present this in more detail below.

Agent theories (Milgrom & Roberts, 1992) describe firms as a quest for control between principals and agents. Principals use contractual relations to allocate agents according to their needs. However, this is much more difficult for relations with outside partners as principals lose their hierarchical advantage.

Innovation economics (Freeman & Soete, 1974; Schumpeter, 1979) enabled the development of large internal laboratories in corporations that enabled them to monopolize innovation by establishing large entry barriers.

All of these theories share the view that open innovation is not preferable to internal innovation. It was only Porter and his five forces model that recognized that the firm is at the centre of the network and other forces (the five forces he describes) are in the network as well (Porter, 1985). Concepts such as barriers to entry have less meaning, and an environment of "co-opetition" transforms the idea of rivalry, buyers and suppliers. The distinctions between companies and markets have been blurred. Some of the challenges of the networked world cannot even be considered from a firm-level perspective, any more than a complex ecosystem can be understood by studying one of its actors, or a chemical reaction can be understood by studying a single reagent. Nevertheless, they still looked at the positioning of the competitive advantage of the individual company inside a network of other players. At the core of Porter's model, the boundaries of the firm remained intact.

The rise of networks has fundamental implications for business strategy and competencies. However, it also complicates and raises the issue of which activities the firms should perform internally and where to set the boundaries of the firm.

It seems that the most useful definition of the firm for researching open innovation is that firms are bundles of activities which simultaneously include different forms of interactions with external actor groups (Ebersberger et al., 2011). This implies that small firms can compete with larger firms through innovation if they collaborate with external partners. As such, open innovation activities can become a tool for small companies to successfully compete with the innovation activities of large companies. The lack of resources does not necessarily hinder their innovation activities, as most theories of the firm would imply.

Empirical evidence confirms that. Some recent studies in the EU find that the SMEs engage in many open innovation practices and have increasingly adopted such practices (van De Vrande et al., 2009). Other studies show that SME's have, on average, a much higher intensity of open innovation practices than large companies (Vanhaverbeke et al., 2012). This finding is further developed (and contradicted) by the most comprehensive study of the effects of the firm size on different open innovation practices reported in the

Open Innovation in Europe Report. It shows that firm size increases the implementation of open innovation practices (Ebersberger et al., 2011). This finding is also true for small firms. However, it clearly shows that SMEs are also actively implementing open innovation practices.

These global changes will be resolved through a combination of technology and social policies. Both will be organized differently than the standard theory suggests.

1.6.2 Contributions of Open Innovation to the innovation policy research

Ever since the theory of open innovation was established, it has influenced innovation policies (e.g. (Chesbrough, 2003). This seems contradictory at first since the open innovation paradigm puts more emphasis on the market transactions in the innovation activities – 'opening' innovation activities that previously belonged to closed organisations. However, that does not mean that the markets for innovation function well.

Government intervention in corporate innovation activities was usually based on the market failure argument. In the world of perfect competition, the market's innate coordination mechanisms would allocate goods and services efficiently. They would reach the Pareto optimum (Arrow & Debreu, 1954). However, since the perfect competition requirement is not fulfilled in the real world, the resulting allocation of resources is not optimal (Greenwald & Stiglitz, 1986). Knowledge has characteristics of a public good as it spills over from creator to other actors who are only limited by their own capabilities in utilizing it. This results in an appropriability problem for the creator of the knowledge. Innovating companies cannot fully appropriate the returns of their innovation and will hence under-invest in knowledge and knowledge creating processes (Arrow, 1962). This reasoning is based on the classical view that goes back to Adam Smith (1845) and neoclassical economics. According to these views, the target for the government is to establish conditions for competition that will channel individual self-interest for the common good.

However, far from creating a perfect world, economic competition often encourages behaviours that not only cause enormous harm to the group but also provides no lasting advantages for individuals, since any gains tend to be relative and mutually offsetting (Frank, 2012). Other theories like evolutionary theory and institutional economic theories, for example the 'varieties-of-capitalism approach' (Hall & Soskice, 2001) and national business system (Whitley, 2000), though sometimes regarded as unorthodox, can better explain the reasoning for government intervention in open innovation systems. According to their view, various institutions are present in both contextual and transactional ecosystems (organization of markets). Actors in such ecosystems try to fulfil their interests by seek ways to position themselves in the institutional environment and by actively trying to use it to their own advantage (Jaklič, 2009, p. 20). In an institutional environment,

linkages among actors and institutions are crucial for successful innovation. Lack of linkages presents a systemic failure and can have crippling effects on innovation (Hwang & Horowitt, 2012). According to these views, the standard market failure rationale for government intervention is not sufficient to promote the development and diffusion of new technologies as innovation is based on a complex evolutionary process distributed in a system of multiple socio-economic agents whose behaviour and interactions are governed not only by market forces but to a greater extent by non-market institutions (Bleda & del Río, 2013). Linkages between actors serve as channels for knowledge diffusion and recombination. Lack of linkages and networking across organizational boundaries represents a system failure, as do lock-ins to specific collaboration partners, sources of ideas and information or excessive overall 'closure' of learning processes (Herstad et al., 2010). These failures need to be tackled in a similar way to market failures – with policy intervention (Woolthuis, Lankhuizen, & Gilsing, 2005).

Based on the market and/or system failure argument supporting innovation policies, it seems clear that open innovation needs elaborate innovation policies. Far from becoming redundant, they remain an essential element of industrial policies. However, the new way of thinking about openness and innovation does influence the changes in innovation policies (Herstad & Bloch, 2008; Herstad et al., 2010). Different policy measures are needed to facilitate open innovation activities than were needed to support innovation in the past. But different in what way?

Open innovation theory does not contradict these insights and firmly supports the notion that government intervention in supporting innovation activities is justified. In fact, the open innovation theory suggests another line of reasoning to support government intervention[3]. It argues that linkages between actors serve as channels for knowledge diffusion and recombination. Lack of linkages and networking across organizational boundaries represents a system failure, as do lock-ins to specific collaboration partners, sources of ideas and information or excessive overall 'closure' of learning processes (Herstad et al., 2010). These failures need to be tackled in a similar way as market failures – with policy intervention (Woolthuis et al., 2005).

There are some concrete examples of market and systemic failures that are inherent in the open innovation concept. It has emphasised the role of innovation and intellectual property agents (such as Innocentive and others), whose role is to promote novel solutions to mitigate market failures. However, these initiatives have not yet widely spread and remain no more than a niche segment of overall innovation activities. Their existence does not solve the market or system failures. Policy intervention is still needed. Researchers and

[3] In fact, the systemic approach to innovation policy was developed into a line of research well before the introduction of the open innovation concept, but fits well with the concept.

policy makers have taken open innovation into account and tried to suggest policy changes that would support open innovation activities.

An OECD study in 2006 specifically tried to provide recommendations on how to connect the new business strategies implementing open innovation with their policy implications (De Backer et al., 2008). More recently, several papers and studies have discussed the question of how national innovation polices can be reframed in a context of open innovation (e.g (Ebersberger et al., 2011; Herstad et al., 2010) and others). They suggest that national level tools are still the ones that represent the most immediate form of intervention into innovation behaviour (Herstad et al., 2010)

1.6.3 Contributions of Open Innovation to the cluster theory

The answer to the idea that linkages between actors serve as channels for knowledge diffusion and recombination had been limited to a narrow geographic area. The idea became very popular and it is hard to find a country that is not trying to develop a network of complementary and competitive firms. A 2006 study identified 1400 cluster initiatives globally (Ketels, Lindqvist, & Sölvell, 2006). At their core, clusters are simply geographically proximate groups of interconnected companies and associated institutions in a particular field, linked by various commonalities and complementarities (external economies) (Porter, 2008). But the definition of geographic proximity is changing due to the on-going developments of globalisation and information technologies. In 1998, Michael Porter wrote: "Now that companies can source capital, goods, information, and technology from around the world, often with the click of a mouse, much of the conventional wisdom about how companies and nations compete needs to be overhauled. In theory, more open global markets and faster transportation and communication should diminish the role of location in competition. After all, anything that can be efficiently sourced from a distance through global markets and corporate networks is available to any company and therefore is essentially nullified as a source of competitive advantage. But if location matters less, why, then, is it true that the odds of finding a world-class mutual-fund company in Boston are much higher than in most any other place? Why could the same be said of textile-related companies in North Carolina and South Carolina, of high-performance auto companies in southern Germany, or of fashion shoe companies in Northern Italy?" (Porter, 1998, p. 76).

For years, the competitive advantage of industrial districts and clusters has been based on product flexibility and production efficiency. The competitive advantage of firms is now less and less based only on simple products. Competition is more and more shifting to a "service" and to a "business model" level. Innovation now has a prominent importance to firms, and hence have innovation-centred strategies, foster the inter-clusters and the international collaboration of, enhance knowledge transfer and knowledge contamination between different entities (universities, research centres, firms, policy makers, consultants,

technology parks, venture capitalists, knowledge brokers, etc.) (Bortoluzzi, 2014). Clusters are focusing on innovation collaboration and activities that can lead to competitive positioning as an innovative node in an innovation network (and consequently, value chain). Economic geographers have argued that interaction with distant partners may be at least as important for innovation as local collaboration (Cotic-Svetina, Jaklic, & Prodan, 2008). Others have found that international linkages within the value chains are associated with superior innovation performance (Herstad & Bloch, 2008). It seems that success of (some) clusters was more based on (innovation) collaboration, not just locating firms in the same place (EIU, 2011). If such collaboration can be established over longer distances, it has at least the same potential to foster innovation as local clusters. Innovation collaboration (and other open innovation activities) is becoming the source of competitive advantage in clusters, just like in companies. Open innovation has contributed to understanding how companies can benefit from such innovation collaboration. It thus also offers the same insights for clusters.

1.7 Conclusions from the literature review

The answer to the three questions that were presented in the beginning of the chapter, is, I believe, that all three are wrong.

1.7.1 Is the open innovation concept a distinct concept or one that will fade away in a decade and merge into the 'standard' definition of innovation?

Our understanding of innovation is comprised of several concepts and is discussed from different viewpoints, so it is unrealistic to expect one concept (such as open innovation) to become the only 'true' innovation concept. A body of knowledge on innovation is comprised of numerous theories (or research programs according to Lakatos (1976)) and each of them sheds new light on a subject – especially one as complex as innovation. Open innovation will never be the only innovation concept as other views on innovation already exist and will continue to exist in the future. However, open innovation does contribute new insights and is clearly different from other concepts, even very similar ones (like user innovation).

1.7.2 Is open innovation actually hindering growth in research and understanding innovation and representing constraint to future research?

The whole body of knowledge on innovation will be comprised of all of them, existing one besides another. Often, they will come from different disciplines. The leaning towards cross-disciplinarily in researching innovation reflects the fact that no single discipline deals with all aspects of innovation. To get a comprehensive overview, it is necessary to combine insights from several disciplines. For a single viewpoint, connected to a single discipline, to claim that open innovation could act as a communication barrier - hindering

growth in research and understanding, thus representing constraint to future research – is presumptuous and wrong. Different viewpoints from different disciplines are welcomed as they all contribute to the growing body of understanding of innovation, even more so if they spur debate and more research. This question should rather be focused on an entirely different area – obtaining precise and accurate definitions of different concepts and showing how to differentiate among them. Border conditions and context dependencies for each concept should be well researched, showing where a certain theoretical concept is no longer useful and a different concepts should be used to increase our understanding of innovation (for example the use of innovation communities – when are open source communities more useful than those that focus on IPR protection – where is user innovation a more useful concept than open innovation).

1.7.3 Is open innovation really a new paradigm in innovation research?

Several examples confirm that open innovation was not a true paradigm shift in innovation activities and their research. It is based on at least a decade-long transition from internal knowledge bases of firms to globally distributed knowledge networks (Herstad et al., 2010). Other innovation concepts have been developed before and in parallel with open innovation, some of them very similar. Some concepts share significant similarities and contribute to each other's knowledge base. The open innovation concept actually describes a set of innovation activities that firms have used before they were described as 'open innovation' and that were recognised previously by scholars. However, Chesbrough assigned a single term for these developments. Open innovation became 'an umbrella that encompasses, connects and integrates a range of already existing activities' (Huizingh, 2011). It has merged together different activities and concepts under one broad concept. It allowed a great increase in both practitioner's and scholar's interest in these activities that has been duly followed. Timing is also important: Interest in open innovation has increased dramatically recently as it may supply elements for a new growth regime that will resolve the current economic crisis. However, even without the crisis, open innovation would still be popular as it is able to conceptualise on-going changes in the innovation process and contribute to both theoretical understanding of innovation and to practitioner's implementation of innovation activities.

1.8 The future of open innovation research

In summary, the table below presents the main contributions that open innovation has brought to the research on innovation.

Table 6: An overview of open innovation's contributions to innovation research

Research questions	Main insights of innovation literature	Open innovation (OI) contribution
What is innovation?	The function of innovation is to introduce novelty (variety) into the economic sphere. With no innovation, the economy will settle into a state with little or no growth. Innovation is crucial for long-term economic growth. Many different types of innovation exist with distinct features that have an influence on their research and implementation.	Open innovation emphasizes the innovation of new business models – business model innovation (Chesbrough, 2006). It also expands core concepts to Open Service Innovation (Chesbrough, 2011). Its focus on the organization of businesses to conduct and exploit innovation describes novel forms of organization (for example 'innovation intermediaries') and networks between companies and partners. It endorses the new 'combinatorial innovation' (Economist, 2014) describing the technological and start-up explosion as a system integration of newly emerging (digital) platforms.
How innovation occurs? (with the insight on the systemic nature of innovation)	A firm does not innovate in isolation but based on extensive interaction with its environment. Innovation journey is a collective achievement (Van de Ven et al., 1999). System and network perspective are useful for the study of innovation.	The main insight of OI is that companies are no longer able to tackle the entire innovation process on their own. It is crucial to have access to external innovation. The number of sources of innovation is now greater, and its origins are increasingly heterogeneous Internal R&D still plays a role. It is not obsolete. However, it takes on other (additional) tasks: it must pay attention to what is going on outside, identify gaps and holes - and remedy them - and facilitate integration; and it can become an additional source of income. Possibly the main contribution of OI is its focus on implementing OI in companies (innovation management).
Clustering characteristics of innovation (in both time and space)	Innovation tends to cluster in certain industries, which consequently grow more rapidly, implying structural changes in production and demand and, eventually organizational and institutional change. It also clusters in time, influencing business cycles.	OI does not focus on the clustering characteristics. It does support crowdsourcing and innovation communities in general, but both areas are more the focus of user innovation.
Effects of innovation on economic performance	Innovation is a powerful explanatory factor of differences in performance between firms, regions and countries. Innovative countries have higher productivity and income then less innovative ones.	There are very few contributions of the effects that OI has on economic growth (although some studies focus on the effects on company growth). Generally lack of broad empirical studies on OI.

The contributions of open innovation are clearly focused on the question of 'How does innovation occur?' Clearly, open innovation has contributed to the understanding how to implement it in companies. With regards to theoretical gaps in this area, intellectual property issues (especially trading), spatial and network aspects of organization of R&D teams, and management research on the operational and implementation aspects of open innovation in organizations are just some of the key areas where more research is needed to facilitate the consistency of open innovation theory, since there is no holistic model of open innovation which would identify all the antecedents of the innovation process, test limits to opening up of organizations following the open innovation paradigm or help us understand the underlying cause-and-effect mechanisms of open innovation practices (Gassmann et al., 2010).

To a lesser degree, open innovation has also expanded the research of innovation to business model innovation and service innovation, using the same premise that 'not all the smart people work for you' (Chesbrough, 2012).

A special area for research in open innovation systems is the connection between these systems and entrepreneurship. Insights on open innovation can be connected to the 'lean' approach to implementing and commercializing innovation. It has become the organizational model of choice for the new start-up companies, emphasizing the rigorous and rapid testing of new solutions (for example: products) with their users. Firms have to find out what customers want. That involves building something, measuring how users react, learning from the results, then starting all over again until they reach what is known as 'product market fit' (Blank, 2013; Ries, 2011). Companies should start with a 'minimum viable product' to gauge the audience's interest. They should always test their assumptions, aiming for 'validated learning' and if their strategy does not work, they should 'pivot' – start again with the new product (Economist, 2014, p. 4) with the new understanding of the customer's needs. This approach is taught by hundreds of start-up schools (often called 'accelerators') and implemented in innovation ecosystems that are highly interconnected with various institutions supporting institutions (large companies, SME's, universities, venture capital companies…). These innovation and entrepreneurial ecosystems are based on innovation collaboration of the kind described by the open innovation research. Organization of these ecosystems that focus on innovation collaboration shows that open innovation systems are theoretically closely related to the 'lean' approach, especially by its contributions in the field of open business models.

The 'lean' approach can be extended from the usual 'lean start-up'(Blank, 2013; Ries, 2011) methodology also to the 'lean' entrepreneurship approach in large companies (Owens & O., 2014) and even to 'lean policy-making'. Similarly, different types of organizations can benefit from open innovation even when they are not developing new products or services (Vanhaverbeke, 2013). Both describe novel forms of organization and

networks between companies and their partners. They endorse the new 'combinatorial innovation' (Economist, 2014) describing the technological and start-up explosion as a system integration of newly emerging (digital) platforms. While the 'lean start-up' approach is more entrepreneurial oriented with the emphasis on supporting practical implications, open innovation can be regarded as the theoretical framework for such innovation collaboration. However, many more theoretical contributions will be needed to wholly connect these two concepts.

Open innovation systems are also a target for economic research. Innovation and technology policies have caught the attention of economists researching economic growth, leading to some theoretical and empirical economic research. A crucial drawback of economic research is the lack of specialised data that would allow the studies of open innovation. This was also one of the findings by the OECD studies that focused on open innovation (K. De Backer et al., 2008). With more and better data, more research on the effects of open innovation on economic performance could be done.

Recently, several areas were recognized that require further research. They include boundary conditions for open innovation (such as workforce mobility, absorptive capacity of the companies involved in OI and the presence of 'not-invented-here' syndrome, rules on intellectual property etc.). Critical success factors for the successful implementation of open innovation in companies are also not fully understood yet. There are clear differences in open innovation implementations. OECD studies report that large corporations are innovating in a more open manner than smaller companies. Other studies confirmed this (van De Vrande et al., 2009) even though they found evidence of open innovation in SME's. Especially small companies have specific characteristics of innovating (Dejong & Marsili, 2006). There are also distinct differences between industries with the largest usage of open innovation found in ICT, pharmaceuticals and chemical industries (Chesbrough & Crowther, 2006).

Nevertheless, open innovation might develop a full, 'holistic' open innovation theory that includes the innovation process's determinants and industry specifics as well as limits to opening it up (Gassmann et al., 2010, p. 7).

Table 6 also shows general area for further research. More work would be welcome in the field of economic effects on open innovation, using empirical studies that remain scarce. Small and medium sized companies (SME's) seem to be able to use open innovation to boost their growth, increasing the innovation dynamics of whole economies. Yet they remain under-researched. Clustering of open innovation in time and space would also require more research (as would the opposite – in which periods and industries is open innovation not used).
There is another field where open innovation has not contributed as much as it could yet, especially with its systemic approach to innovation: organization of innovation work

between companies. A major focus of open innovation has been targeted on how to organize for innovation within companies. Much less has been invested into research on how to organize the environment between businesses and other institutions or entire national, regional and global innovation ecosystems that support (and are influenced by) open innovation. As Chesbrough himself has put it: 'Further research is needed in the field of designing and managing innovation communities' (Chesbrough, 2012, p. 26). I will try to provide some initial discussions on the organizational issues that could benefit from more research.

1.9 Organizational challenges of new innovation practices

As I have shown in the introduction to the dissertation, the developments in the past couple of decades have changed the prevalent innovation practices that have led to new theories of innovation, including open innovation. The context of this development was based on two major shifts in the economic environment: the expansion of innovation activities from large companies to others, often described as a decline of the Fordist regime of innovation organisation after 1970's, and the geographical expansion of innovation activities – the globalisation of innovation.

These trends have only become widespread relatively recently and are expected to continue for a long time. In addition to the generally vigorous pace at which the global total of R&D is now growing, the other major trend has been the rapid expansion of R&D performance in the regions of East/Southeast Asia and South Asia (Fundation, 2012). The combined share of R&D expenditure of non-high income economies has only exceeded 10 % of the total global R&D expenditure in 2008. At that time the combined share of BRIC countries only accounted for 7 % of the global total. However, the continuation of the current development trends will assure that the BRIC's alone will invest a quarter of the (significantly larger) global R&D expenditure by 2025. Developing countries are becoming hotbeds of business innovation in much the same way that Japan did starting in the 1950s (Wooldridge, 2010). They changed the global organization of innovation.

This has had significant consequences on the global organization of innovation activities. In the initial stages of globalization, developed countries have been off-shoring production to low-wage countries to achieve cost-advantages with the effect that global value chains have emerged. They used greater profits to finance increasing R&D and marketing projects at home and to satisfy demanding shareholders and financial markets (Kristensen, Lilja, Jaklič, & Pustovrh, 2011). Though this change caused layoffs of employees in Western economies, their huge concentration of knowledge intensive institutions and R&D headquarters of large multinationals seemed also to promise that they could help their home economies evolve towards knowledge societies by enlarging R&D, design and advanced business services such as finance, marketing and consultancy. This scenario followed from the expectations that only large corporations of developed countries were

able to finance large R&D-labs that turned out new products if supported sufficiently by basic research institutions (Kristensen, 2010).

This way of reorganising the international economy still plays a dominant role, but it also triggers counter-strategies from other players. First, many low cost countries imitate the highly developed ones by investing in R&D and higher education so that their enterprises can take on increasingly advanced tasks and be allocated innovative projects within the existing global value chains. This evolution started in Israel, Ireland and Taiwan and is diffusing to BRIC-countries (Kristensen et al., 2011). Simultaneously Western small- and medium-sized enterprises (SMEs) that used to supply repetitive components for the large multinationals have become much more innovative (Kristensen et al., 2009; Kristensen & Zeitlin, 2004). Innovation in some developed countries has shifted from being dominated by large multinational companies to be dispersed among all firm sizes, collaborating mutually in open innovation systems. Today, even the largest multinational companies must become part of global networks of firms, research institutions and internet communities to be able to follow technological advances. They must constantly adapt their own role and business model to the role that other network-participants aspire to. It is not enough to develop the next product in internal labs and to off-shore maturing production processes (Herrigel, 2010).

This shift from centralized, 'closed' innovation organized in R&D labs financed by large multinational companies towards open innovation organized in (inter)national innovation systems challenges paradigms for industrial and innovation policies of advanced countries. This raises a host of organizational problems for firms and public institutions. How states can support them in answering them lies at the heart of the new generation of innovation policies (Kristensen et al., 2011). Firms may need to take into account wider social and economic implications of an innovation project and may need to think about the way to join up with other agents of change in the private and public sectors. Policy makers need to think about different policies that support innovation. If the 'closed' innovation concept was focused on providing sufficient resources for research and development (taking place in large R/D laboratories in multinational companies), the aim of policy makers was to support increased investments, usually by subsidizing them directly or by implementing tax breaks. Another area for policy makers was the removal of bottlenecks that occur at the system level in the areas such as skills, research infrastructure and broader infrastructure. However, open innovation systems emphasize the role of linkages, so the removal of systemic failure should also be targeted. The global competition for innovation actors and innovation platforms opens new challenges for policy makers, focusing on the ways to make a certain environment attractive to become the innovation hub (which is likely not dependent on 'narrowly' defined innovation policies we know today, but rather depends on more 'broad' policies that make an entire environment more attractive to innovative companies).

The transformation towards open and networked innovation systems also holds opportunities and challenges for small and medium sized companies. By becoming more innovative and by joining into innovation collaborations with others (including multinational companies) they can cooperate and compete with companies that used to be too big for them. Following the global restructuring of large multinational companies, innovative SMEs have become small multinationals (SMNCs) and thus created an organizational phenomena long held by business economists to be economically fragile (Kristensen & Lilja, 2011; Kristensen & Zeitlin, 2004).

In conclusion, the organizational dimension in transitions to open innovation systems is overlooked. By ignoring the organisational difficulties of open innovation systems, social science underestimates the numerous forms of social innovation that are called for in bringing about open innovation systems, since their very existence run counter to most theoretical advances over the last forty years in the economics of the organisation.

Based on the analysis of open innovation above, I will focus my PhD on three research areas identified above.

Table 7: Three research areas in focus of the dissertation

Each of these areas will be a focus of a chapter of this dissertation:
Use of open innovation in SME's and opportunities and challenges that it holds for their innovation, commercialization and growth.
Analysis of the importance of policy measures supporting linkages and entrepreneurship for innovation success of national innovation systems.
The analysis of 'narrow' and 'broad' policies influencing innovation on national innovation success.

CHAPTER 2: ANTECEDENTS OF HIGH-TECH SMALL AND MEDIUM SIZED ENTERPRISES'S COMMERCIALIZATION ENABLERS: OPENING THE BLACK BOX OF OPEN INNOVATION PRACTICES

Innovation activities have become globalised and open in ways that were unimaginable 20 years ago (Wooldridge, 2010). These changes have brought new insight into research on innovation activities and specific innovation practices in organizations. In particular, the concept of *open innovation* has attracted considerable interest from both managers and academia (Huizingh, 2011). However, in today's highly competitive world innovativeness should be seen as necessary, but insufficient for organizational performance and long-term success (Hult, Hurley, & Knight, 2004; Tsai & Yang, 2013). This is because today "successful innovation is typically defined at the firm level using indicators such as market shares, productivity, or profitability" which are all commercially based (Palmberg, 2006, p. 1253). Such a perspective calls for a better understanding of the internal organizational link between innovativeness and commercialization of innovation in organizations (Černe, Jaklič, & Škerlavaj, 2013); particularly small and medium sized enterprises (SMEs). Existing research on open innovation has been limited (van de Vrande et al., 2009). The same is true about the role that specific open innovation practices play in fostering this link.

We have introduced the concept of commercialization enablers as a set of activities which companies use in order to align themselves more closely to the market needs and to help the results of their innovation reach the market. Such a concept has been developed fairly recently and has been previously employed in the analysis of commercialization of publicly developed innovation (Berggren, 2013). Similar to market orientation, this concept is not trying to measure commercialization through its results (such as revenue or profitability), but rather as an influence force facilitating innovation to "cross the chasm" to the market (Moore, 2006). It aims to »encourage people to do more market value research and commercialize their products in global market« (Nagaretham, 2012, p. 160).
In my research, I operationalize and test commercialization enablers through specific firm activities and organization changes which facilitate commercialization of innovation; where partnership-based behaviour, in particular, plays an important role (Schoeman, Baxter, Goffin, & Micheli, 2012). As shown in table 9 below, I have used four specific variables to measure company's internal restructuring and external realignment in order to benefit more from its innovativeness. Among them, business model innovation has recently been the focus of considerable attention in the open innovation literature (Chesbrough, 2006).

Despite the almost panacean status of open innovation particularly within the innovation management literature (Chesbrough, 2003; Gassmann, 2006; van de Vrande et al., 2009), significant theoretical and empirical gaps still remain in our understanding of open innovation. They were presented in the previous chapter, but one of the most important gaps are empirical studies of open innovation. In terms of empirical gaps, van de Vrande et al. (van de Vrande et al., 2009, p. 423) point to open innovation research focusing mostly on: "large, high-tech multinational enterprises (MNE) drawing on in-depth interviews and case studies" (Chesbrough, 2003; Kirschbaum, 2005). Thus, van de Vrande et al. (2009), as well as Gassmann et al. (Gassmann et al., 2010) explicitly recognize SMEs and their management of open innovation as one of the biggest empirical gaps related to the open innovation literature. This is despite the acknowledged importance of SMEs as key innovation players in most economies (van de Vrande et al., 2009; *cf*. Chesbrough, 2003). Even the authors who have recognized the empirical gap related to open innovation in SMEs have not been able to answer *how* SMEs implement and manage specific open innovation practices, as well as position themselves within relevant innovation networks. Furthermore, there are only a handful of empirical studies targeting the implementation of open innovation activities specifically in SMEs (van de Vrande et al., 2009). All of these studies focus either on Western developed economies like the Netherlands (e.g. van de Vrande et al., 2009), or Asia – especially South Korea (e.g. Lee et al., 2010). Thus, apart from Radas & Božić's (2009) paper on the antecedents of SME innovativeness in Croatia, little is known about either SME innovativeness, let alone SME open innovation in other transition or post-transition economies – like Eastern Europe – in which SMEs usually constitute a much larger share of the economy (Morec & Rašković, 2011) and face more constraining external and institutional obstacles to innovation (Radas & Božić, 2009).

Building on the specifics of high-tech SMEs in transition economies (Radas & Božić, 2009), the characteristics of the open innovation philosophy (Chesbrough, 2003), and on the crucial role of successful commercialization of innovation for the survival of SMEs (Lee, Park, Yoon, & Park, 2010; Palmberg, 2006), this chapter tests an integrated variance-based structural equation model (SEM) of antecedents of commercialization enablers among Slovenian high-tech SMEs. It integrates the traditional internal-external determinants' perspective of high-tech SME innovativeness (e.g. Radas & Božić, 2009) with a focus on the role of specific open innovation practices in high-tech SMEs (van de Vrande, 2009) in trying to provide answers to two research questions.

The first question I ask in this chapter questions what are the specific antecedents of high-tech SMEs' commercialization enablers? Additionally, I would like to know how do two specific open innovation practices (open innovation information exchange and open innovation collaboration) impact high-tech SMEs' commercialization enablers through their innovation activities and innovativeness?

In addition to integrating Radas & Božić's (2009) work on the internal and external antecedents of SME innovativeness with the work by van de Verde et al. (2009) on the application of specific open innovation practices within high-tech SMEs, the second important theoretical contribution of my chapter is testing the impact of innovation activities of high-tech SMEs and their innovativeness on the commercialization and its enablers in high-tech SMEs. This is consistent with Chesbrough's (2003) understanding of commercialization being an integral consequence of open innovation. This chapter contributes to a better understanding of specific processes and activities which are leveraged by high-tech SMEs through their open innovation process in order to commercialize their innovation. Furthermore, my results also open the black box of high-tech SMEs' open innovation processes, which is particularly valuable for the SME innovation management literature. While the empirical contribution of my research should be seen in its survey-based dataset of high-tech SMEs from an East European post-transition economy, the methodological contribution of my research should be viewed in its move away from traditional interview- and/or case-based data (van de Vrande et al., 2009). Additionally, the employment of SEM may be more suitable for the testing of complex and multi-item latent constructs (like e. g. innovativeness) which have so far at best been reduced to single variables in simplified regression models with unrealistic (methodological) assumptions.

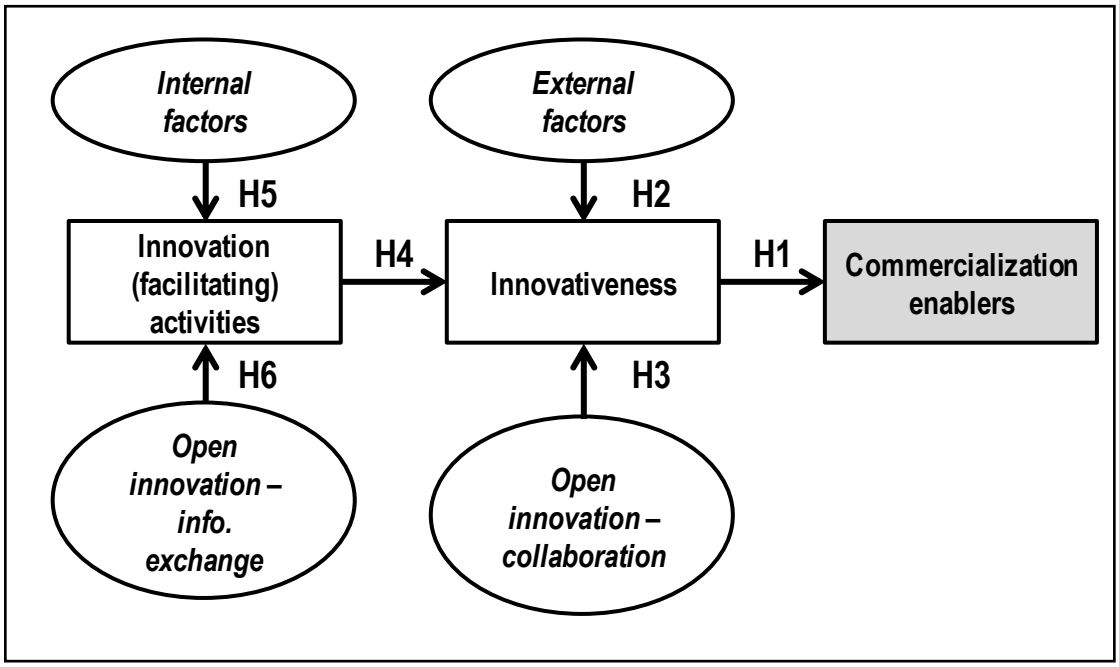
2.1 Theoretical framework and research hypotheses

SMEs tend to focus on later stages of innovation, especially the commercialization stage (Chesbrough, Vanhaverbeke & West, 2006). Lee et al. (2010), for example, call for a special model of explaining innovation activities of SMEs, which would emphasize the role of intermediaries and their role in both innovation and commercialization activities of SMEs. Parida, Westerberg & Frishammar (2012) have, on the other hand, constructed a model showing how different open innovation practices lead to different innovation performance results in SMEs. In their work, the commercialization of innovation activities has been more strongly emphasized (compared to large enterprises). Despite recent attempts to better understand the context- and contingent-specific characteristics of SMEs' innovation activities and their commercialization outcomes, there is still a general lack of research on the effects that open innovation has on commercialization activities in SMEs, even though it is recognized as particularly important for them. This is surprising, since commercialization of innovation has been an integral consequence of the open innovation concept from the very beginning (Chesbrough, 2003).

Our conceptual model in Figure 6 outlines six underlying research hypotheses (H1-H6). Commercialization enablers of high-tech SMEs represent the key endogenous latent construct of the model, which is in turn driven by the antecedent-determinant relationship between high-tech SMEs' innovation activities and their innovativeness. The reason for not focusing explicitly on innovation performance – as it is usually the case in research on

high-tech SMEs (Hult et al., 2004; Radas & Božić, 2009) – but rather on commercialization enablers stems from the fact that Van de Vrande et al. (2009) have shown on a sample of Dutch SMEs that high-tech SMEs' primary motivation behind (open) innovation is much more commercially-oriented, compared to other types of high-tech enterprises. Lee et al. (2010) have also supported such a view by showing how commercialization of innovations is the overwhelming performance criterion for Korean high-tech SMEs. On the other hand, Aarikka-Stenroos & Sandberg (2012) have more recently also pointed to a clear research gap related to the role of open innovation networks and their explicit impact on innovation commercialization activities, as part of business performance in high-tech enterprises in general.

Figure 6: Proposed conceptual model of the antecedents of commercialization enablers of high-tech small and medium sized enterprises



Source: Authors' conceptualization based on relevant literature review (see also Table 9).

Our conceptual model was developed by integrating the work by Radas & Božić (2009) on the antecedents of SMEs' innovativeness with the work by Rhee, Park & Lee (2010) on the drivers of innovativeness and performance in high-tech SMEs and Chesbrough's (2003) open innovation model. According to this model, any enterprise strives to combine internal and external R&D and innovation processes through buying, outsourcing and/or licensing various types of innovations, processes and/or know-how, as well as by coupling them with external information and diverse collaborative behaviour in order to push its innovation to the market through various types of commercialization enablers by better optimizing its resources and leveraging various types of internal and external competitive capabilities (Chesbrough, 2003).

While some authors define innovation commercialization solely and narrowly through its market-success (Nerkar & Shane, 2007), I conceptualized commercialization enablers of high-tech SMEs more broadly through high-tech SMEs' self-perceived organisational changes that are implemented to achieve the success of their innovations in the market (see Table 9 for a more detailed overview of construct operationalization). This approach is similar to the four so-called 'inside-out' open innovation activities aiming to connect a given enterprise across its boundaries in order to reach and succeed in the market (Chesbrough, 2003).

In my model the relationship between innovativeness and commercialization enablers of high-tech SMEs is grounded in the literature on the positive relationship between innovativeness and business performance through the competitive advantage-building nature of innovation (Damanpour, 1991; Porter, 1990). In this regard, the positive impact of innovativeness on business performance has been described both in the mainstream organizational literature as "generally known to be true" (Hult et al., 2004, p. 431), as well as more specifically in the literature related to high-tech SMEs (Rhee, Park, & Lee, 2010). In my case, I have replaced business performance with commercialization enablers, based on the increased importance of such reorganisation in achieving business performance among high-tech SMEs (van de Vrande et al., 2009), as well as based on the so called chain-linked model of innovation (Kline & Rosenberg, 1986; Palmberg, 2006). In this model, the final (fifth) stage corresponds to successful development of commercialization enablers and is also strongly dependent on the type of innovation (this also has implications for research hypothesis H3). Finally, and particularly relevant to high-tech SMEs, the impact of innovativeness on commercialization is believed to be especially strong because of the role of entrepreneurial orientation (Slater & Narver, 1995) which Hult et al. (2004) have emphasized in analysing the impact of innovativeness on business outcomes among high-tech SMEs. However, even though entrepreneurial orientation in high-tech SME's can facilitate commercialization, this is not certain without commercialization enablers. They improve the chances for successful commercialization by influencing changes in the firm's activities and organisation. Supporting this hypothesis is also recent evidence by (Parida et al., 2012) who were able to show a clear positive link between specific open innovation policies (e.g. technology sourcing, technology scouting) on innovation performance of high-tech SMEs, including commercialization.

Hypothesis 2.1*: Innovativeness will have a positive impact on commercialization enablers in high-tech SMEs.*

In my model, the innovativeness of high-tech SMEs is believed to be determined by three constructs, namely external factors (H2), open innovation based on collaboration (H3) and the actual innovation activities of high-tech SMEs (H4). While Radas & Božić (2009) adopted the classification of external factors based on (Keizer, Dijkstra, & Halman, 2002) three groups of external factors – namely: the supporting institutional environment, linkages to other firms and linkages with other knowledge centres – I wanted to more clearly distinguish the open innovation aspects of such external factors from the institutional and support environment factors (which I simply call external factors in my model). This is because previous empirical research on the role of institutional and support environment factors has shown this to be a particularly relevant issue for Slovenia (as a post-transition society) and an inhibitor of its high-tech SMEs (Rašković, Pustovrh, & Jaklič, 2012; Rašković, Pustovrh, Jaklič, & Makovec Brenčič, 2011). In the case of both H2 and H3 Radas & Božić (2009), as well as e.g. Meer et al. (1996) and Birchall, Chanaron & Soderquist (1996) it has been shown that differences in both the institutional and support environments, as well as the implementation of collaborative behaviour (particularly across industries and with universities) have a positive impact on the level of firm innovativeness.

Hypothesis 2.2*: External factors will have a positive impact on the innovativeness of high-tech SMEs.*

Innovation collaboration is another standard open innovation practice, already defined by Gassmann & Enkel (Gassmann & Enkel, 2004) as a coupled innovation activity. Due to its dual nature in both influencing internal innovation activities and providing a path for the flow of internal knowledge to partners outside the boundaries of the firm, I expect these factors to influence the overall innovativeness of the firm, including not only its internal innovation activities but also other external factors. This is also consistent with the literature summarized by (Keizer et al., 2002) which shows that collaboration is joined by other external factors in its influence on innovation efforts. Lastly, the link between external collaboration and innovativeness is also clearly emphasized in Chesbrough's (2003) first stage of the open innovation process.

Hypothesis 2.3: *Open innovation collaboration will have a positive impact on the innovativeness of high-tech SMEs.*

With regards to the next hypothesis, I explicitly differentiate between innovation activities of the firm that are by definition internal and innovativeness, defined as the capacity to introduce some new process, product, or idea to the market (Garcia & Calantone, 2002). Accordingly, in my model internal factors influence innovation activities while external

factors supplement firm's innovation activities in influencing the innovativeness of the firm. This distinction was also influenced by Lee et al. (2010) who observed that SMEs tend to be "less active than large firms in most innovation activities" (p. 294). Such an observation clearly delineates the need to specifically study the level and types of various innovation activities in terms of their impact on high-tech SMEs' innovativeness and subsequent performance. According to Lee et al. (2010), this is related to their different market positions (e.g. high-tech SMEs usually cater to individual large customers mainly through product customization), as well as the fact that SMEs are in a completely different position to seize external environmental opportunities (Radas & Božić, 2009). In addition, the discussion on the ambiguity of the innovativeness concept in the innovation literature by Garcia & Calantone (2002) also supports the distinction between innovation activities and firm innovativeness.

Hypothesis 2.4*: Innovation activities will have a positive impact on the innovativeness of high-tech SMEs.*

With regards to this hypothesis, it is also important to note that innovation activities measured in this way are internal (inside the boundaries of the firm) but nevertheless fit into the open innovation framework since they are influenced by external knowledge. In this way, they hold similarities in measuring the absorptive capacity of the firm. The innovations activities construct thus represents the internal part of the innovation process in the firm and combines with other factors to influence innovativeness of the firm.
Drawing again on the work by Radas & Božić (2009; *cf.* Keizer, Dijstra & Halman, 2002), as well as influenced by the so called Resource-based view of the firm (Wernerfelt, 1984) where firm competitive advantage is derived through the process of "channelling resources into the development of new products, processes" (Hult et al., 2004, p. 431) the fifth hypothesis corresponds to the relationship between internal factors and high-tech SMEs' innovation activities.

Hypothesis 2.5*: Internal factors will have a positive impact on the innovation activities of high-tech SMEs.*

This hypothesis is grounded in abundant empirical research which besides the importance of internal funds and R&D investment (Oerlemans, Meeus, & Boekema, 1998) also emphasizes the positive influence of myriad other internal factors on the innovation activities of high-tech enterprises – for example: top management support and appropriate leadership (e.g. LeBlanc et al., (1997); Hoffman et al., (1998), strategic management e.g. (Carrier, 1994), project management (e.g. Meer et al, (1996), human capital (e.g. Hoffman et al., 1998; LeBlanc et al., 1997), as well as specific technology supporting policies (e.g. Oerlemans et al., (1998).

The last hypothesis is perhaps the most intuitive of the six, since it relates to the positive relationship between openly exchanged information beyond the organizational boundaries and high-tech SMEs' innovation activities. It relates to the standard outside-in open innovation practice of using different knowledge sources in the external environment (Laursen & Salter, 2006). While it is consistent with the so called Resource-based view of the firm – by treating information as a key resource for innovation activities – it clearly emphasizes the importance of external knowledge and information sharing as the cornerstone idea of the open innovation philosophy (Ye & Kankanhalli, 2013).

Hypothesis 2.6*: Open innovation information exchange will have a positive impact on the innovation activities of high-tech SMEs.*

2.2 Data and methodology

2.2.1 Data

Our data set includes a sample of 105 high-tech SMEs[4] from both manufacturing and service industries,which employed at least five people. I focused only on high-tech enterprises with at least five employees, assuming that enterprises with less than five employees were generally too small to engage in *systematic* and comprehensive innovation activities (Arvanitis & Hollenstein, 1998). Overall, I estimated the whole population of Slovenian high-tech SMEs to include 108 high-tech manufacturing and 2,156 SMEs related to knowledge-intensive services (KIS). This was taken from the 2011 Slovenian business register and estimated based on Eurostat's (Eurostat, 2009) identification of specific high-tech manufacturing and knowledge-intensive service (KIS) sectors, as well as the recommendations from OECD's Oslo manual (OECD, 2005). This is the dominant and most widely accepted approach to high-tech enterprise identification today.

Table 8: Sample characteristics

Structure by size		Sector breakdown		Demographics	
Micro enterprises (5-10 employees)	59.6 %	Knowledge-intensive services (KIS)	74.7 %	Median age	18 years
Small enterprises (10-50 employees)	25.3 %	High-tech manufacturing	25.3 %	Median number of employees	17 employees
Medium enterprises (50-250 employees)	15.2 %			Median gross added value per employee	34.821 EUR

Source: High-tech SME survey, 2012 (n=105).

[4]I employed the OECD definition of SMEs, with small enterprises employing up to 50 employees, and medium-sized enterprises employing from 51 to 250 employees.

Data collection took place between September and October of 2011 through a web-based survey accompanied by telephone reminders and follow-ups. Our respondents were managers responsible for innovation activities within their enterprise. The response rate among high-tech manufacturing enterprises was 23.1 % (mainly due to intensive telephone follow-ups), while the response rate among KIS enterprises was 3.4 %. This low response rate is in my opinion mainly due to a much larger population of KIS enterprises, as well as the limitations of a sectorial identification of high-tech service enterprises, where not all SMEs engaged within a specific KIS sector are actually high-tech enterprises. Table 8 summarizes key descriptive statistics pertaining to our sample needed for the interpretation of my results.

2.2.2 Operationalization of constructs

Based on the conceptual model presented in Figure 6, Table 9 provides a summary of my construct operationalization. All constructs were measured as multi-item reflective latent constructs with 7-point Likert-type scales (1-lowest possible value and 7-highest possible value). The only exception was the construct of open innovation collaboration which was measured in a nominal way with the respondents choosing between not collaborating or collaborating with five different types of partners (see Table 9) domestically, in the EU, in ex-Yugoslavia, in the US, or in other regions. I have not only measured various types of collaboration but also their geographical breadth. This aspect is particularly relevant given Slovenia's small export economy status and strong geographical concentration of its exports.

Table 9: Construct operationalization

Construct	Operationalization (item descriptions)	References
INTERNAL FACTORS	• Strategic focus and explicitness of company strategy • Top management support • Existence of an independent innovation strategy • Availability of internal R&D activities including finances • Organizational structure of the company (e.g. innovation project teams) • Internal availability of human resources • Internal system of employee motivation • Innovation output controlling system • Internal culture of innovation and creativity • Time for experimentation, innovation and creativity • Connection between marketing and R&D functions	Adopted from the work of Keizer, Dijkstra, & Halman (2002), Radas & Božić (2009)
EXTERNAL FACTORS	• Availability of human resources on the labour market • Infrastructure • Availability of technology and materials	Adopted from Keizer, Dijkstra, & Halman (2002), Radas & Božić (2009)
OPEN INNOVATION – INFORMATION EXCHANGE	• Technology transfer offices • Entrepreneurship incubators • Research partners • Conference and business fair visits • Scientific publications	Similar to Laursen & Salter (2006)
OPEN INNOVATION – COLLABORATION	• Collaboration with suppliers of equipment, spare parts and/or software • Collaboration with customers • Collaboration with consultants, commercial labs, private R&D institutions • Collaboration with universities or high schools	Similar to Antikainen, Mäkipää, & Ahonen (2010), Gassmann & Enkel (2004), Lee et al. (2010)
INNOVATION (FACILITATING) ACTIVITIES	• Perceived support for product and process innovation • External R&D usage for internal innovation • Presentation of external knowledge to internal R&D personnel • Establishment of special departments for individual innovations • Changes to the organisational structure of the company to boost innovation	Adopted from Lee et al. (2010)
INNOVATIVENESS	• Support for technical innovations based on research findings • Following and measuring R&D activities and outcomes • Capability to implement fast changes in design, product, service, process • Capability for technological changes in processes based on market demands • Capability of technological changes in products and services based on market demands • Focus on new product development • Focus on new service development	Adapted from Hult et al. (2004), Hurley & Hult (1998), Rhee et al.(2010)
COMMERCIALIZA -TION ENABLERS	• Connections with existing external partners • Development of new business models • Acquiring new business models from another company • Finding new external strategic partner	Adapted from Rhee et al.(2010), Chesbrough (2003)

2.2.3 Methodology

Given the latent nature of our analysed constructs (e.g. innovativeness), as well as their reflective multi-item nature, I employed Structural Equation Modelling (SEM) to test my conceptual model from Figure 6 and to assess the importance of specific antecedents of commercialization enablers of high-tech SMEs in Slovenia. SEM was also employed as a gold standard methodology in managerial research (Babin, Hair, & Bowles, 2008) and because it enables the simultaneous assessment of "latent variables at the observation level (outer or measurement model) and […] relationships between latent variables on the

theoretical level (inner or structural model)" (Hair, Sarstedt, Ringle, & Mena, 2012, pp. 414–415).

Within SEM, I decided to employ a variance-based Partial Least Squares (PLS) modelling approach rather than the traditional covariance-based Ordinary Least Squares (OLS) modelling approach. Several factors influenced my choice of PLS SEM: our survey-based variables were not distributed normally; my model testing is exploratory in nature; the sample size is limited;, the model is fairly complex (given the sample size); there is potential item multi-colinearity; and my focus is to estimate the predictive power of my model. In all of these cases, PLS SEM has been recommended over OLS SEM, despite its lack of fit statistics and global optimization criteria (Hair et al., 2012; Hensler, Ringle & Sinkovics, 2009). My PLS SEM was tested using smartPLS 2.0 (Ringle, Wende, & Will, 2005).

2.3 Results

2.3.1 Confirmatory factor analysis

Confirmatory factor analysis (CFA) is frequently used as a first step to assess the proposed measurement model in the structural equation model. CFA is used to test whether measures of a construct are consistent with a researcher's understanding of the nature of that construct (or factor). As such, the objective of confirmatory factor analysis is to test whether the data fit a hypothesized measurement model. Unlike SEM, CFA factors are not presumed to directly cause one another. In fact, factor analysis is defined as a measurement and estimation of latent constructs, excluding any causal relationship between latent constructs. On the other hand, SEM in my case already specifies particular factors and variables as well as their causality. Pre-specified factors are also the reason why I could use confirmatory factor analysis and not exploratory factor analysis, but for the analysis of relations between the latent variables (called 'the structural model'), the SEM method has to be used.

With PLS-SEM, the analysis begins with a structural model and confirmatory factor analysis results are already part of the initial calculations (Astrachan, Patel, & Wanzenried, 2014). The initial output includes metrics to assess the measurement characteristics of the proposed model. These metrics include indicator loadings (called outer loadings in SmartPLS), cross loadings, Cronbach alphas and composite reliability, convergent validity (AVE), interconstruct correlations and others. In the process of operationalizing the constructs, a systematic process of examining the loadings and removing the indicators with loading significantly below 0.7 was followed (Hair, Black, Babin, & Anderson, 2010). I allowed two exceptions where indicators with loadings below 0.7 (but above 0.6) were used for two constructs that would otherwise be under-specified. The analysis of cross loadings also showed that all loadings on other constructs were always at least 0.2

lower than the loadings on the construct it was describing. In the case of two indicators that had construct loadings below 0.7, I made sure that cross loadings to other constructs was 0.3 lower than the loading on the target construct. The information on the outer loadings and cross loadings is presented in the attachments C and D.

The resulting model is presented in the Table 10 below. Cronbach alpha values confirm that the construct of External factors is slightly below the normal threshold of 0.7, thus only marginally reliable. However, all other constructs are highly reliable. Based on the high loadings, sufficient differences between cross loadings high Cronbach alpha's, I can conclude that the measurement model is thus validated.

Table 10: Cronbach alpha coefficients and number of indicators for each construct in the model

Construct/Statistic	Cronbach alpha	Number of indicators
1-Commercializastion activities	0.80	4
2-External factors	0.67	3
3-Innovation activities	0.75	5
4-Innovativeness	0.89	7
5-Internal factors	0.95	12
6-Open innovation – collaboration	0.71	4
7-Open innovation – info. Exchange	0.85	5

Source: High-tech SME survey, 2012 (n=105).

2.3.2 Descriptive and fit statistics

Many of the rules of interpretation of regarding the assessment of model fit and model modifications in structural equation modelling apply equally to CFA. I present these results in the table below. Table 11 displays the correlation matrix between the measured latent constructs in my SEM from Figure 1, further accompanied by basic descriptive statistics, and the corresponding reliability and validity statistics.

As we can see from the simple mean scores related to my constructs in Table 11, the average level of innovativeness is a mean score of 5.14 on a 7-point ordinal scale which ranks it high within our sample of Slovenian high-tech SMEs. This is followed by a moderately high level of internally available factors to support innovation activities within our high-tech enterprises (4.78). On the other hand, an extremely low mean score of just 1.22 indicates a virtually non-existent employment of open innovation collaboration practices, which is closely followed by a lack of another open innovation practice – using open innovation information sources (a mean score of 2.37). All of this indicates (on average) a very limited employment of two specific open innovation practices – namely

open innovation collaboration and open innovation information sources – among our sampled Slovenian high-tech SMEs.

Table 11: Construct correlation matrix and descriptive statistics with reliability and validity analysis

Construct/Statistic	Mean	SD	CR	AVE	1	2	3	4	5	6	7
1-Commercializastion activities	2.41	1.54	0.87	0.62	***0.79***						
2-External factors	3.77	1.24	0.81	0.59	*0.10*	***0.77***					
3-Innovation activities	2.47	1.28	0.81	0.52	*0.43*	*0.22*	***0.72***				
4-Innovativeness	5.14	1.29	0.91	0.60	*0.34*	*0.38*	*0.47*	***0.78***			
5-Internal factors	4.78	1.33	0.95	0.63	*0.35*	*0.38*	*0.34*	*0.47*	***0.79***		
6-Open innovation - collaboration	1.22	0.80	0.82	0.54	*0.17*	*0.19*	*0.27*	*0.34*	*0.32*	***0.73***	
7-Open innovation – info. exchange	2.37	1.32	0.89	0.61	*0.55*	*0.00*	*0.33*	*0.09*	*0.20*	*0.17*	***0.78***

Notes: Mean=simple average, SD=standard deviation, CR=composite reliability, AVE=average variance extracted.

Source: High-tech SME survey, 2012 (n=105).

Looking at the corresponding internal reliability statistics, we can see that composite reliability (CR) is sufficiently high in all cases and well above the minimum 0.7 value outlined by Hair et al. (2010). This is also true for convergent validity, where the average variance extracted (AVE) is above the 0.5 value in all cases (as suggested by Fornell & Larcker, 1981). Finally, the square roots of AVE on the diagonal are sufficiently higher than any single pair-wise Pearson's correlation coefficient, which satisfies the criteria for sufficient discriminant validity (Chin, 2010). All pair-wise Pearson's correlation coefficients between any of my analysed constructs are low to moderate, with the highest pair-wise Pearson's correlation coefficient being β=0.55 between commercialization enablers and open innovation information sources.

2.3.3 Structural equation modelling results

Having established the appropriate reliability and validity of my modelled constructs, Table12 presents the results of the PLS SEM testing of my conceptual model from Figure 6.

Table 12: Structural equation modelling results with corresponding path coefficients and significance levels

Path (research hypothesis)	Path coeff.	R^2	t-value (based on bootstrapping)	Df**	p (2-tailed level)
Internal factors → Innovation activities	0.82	0.17	2.97	499	0.003
Open innovation information sources → Innovation activities	0.32		1.91	499	0.057
External factors → Innovativeness	0.11	0.33	2.80	499	0.005
Innovation activities → Innovativeness	0.21		4.33	499	0.000
Open innovation collaboration → Innovativeness	0.17		2.31	499	0.021
Innovativeness → Commercialization activities	0.68	0.12	4.43	499	0.000

Notes: *Path coefficient significance levels based on bootstrapping (500 samples).
**Df=Degrees of freedom; Determined as the number of bootstrapping samples minus 1 (Sosik, Kahai, & Piovoso, 2009).

Source: High-tech SME survey. 2012 (n=105).

As we can see from the PLS SEM results in Table 12, five out of the six hypothesized path coefficients are statistically significant at $p<0.05$, with the only exception being the hypothesized path coefficient between open innovation information exchange and innovation activities (hypothesis H3). Generally speaking, we can observe that internal factors have a highly positive (γ=0.82) and significant (p=0.003) impact on the level of innovation activities within our sample. This is in contrast to the impact of open innovation information exchange on innovation activities where this impact is positive, but non-significant (γ=0.32; p>0.057).

With regards to the antecedents of innovativeness, high-tech SMEs' innovation activities have a high positive impact on their innovativeness (β=0.21; p=0.000), followed by open innovation collaboration (γ=0.17; p=0.021) and external factors (γ=0.11; p=0.005). In turn, the high-tech SMEs' degree of innovativeness also significantly positively determines their commercialization enablers (β=0.68; p=0.000) which supports the existing theory on the link between innovativeness and commercially-based business performance (Palmberg, 2006). In terms of the predictive power, my PLS SEM the antecedents of commercialization enablers explain some 12 % of our dependent reflective latent construct of commercialization enablers within Slovenian high-tech SMEs, which compares favourably to traditional econometric studies and reflects the complex nature of commercialization enablers within high-tech SMEs anywhere.

2.3.4 Control variables

We have also tested two specific control variables – namely industry type (manufacturing or knowledge-intensive services) and enterprise size (small or medium-sized). Both were included in the model as formative single-item dummy constructs. Table 13 presents the results of testing the impact of industry type and enterprise size on commercialization enablers of our high-tech SMEs. As we can see, neither industry type or enterprise size seem to have a significant impact on commercialization enablers (R^2 change of 0.026) of Slovenian high-tech SMEs which in turn provides an additional robustness check for my model.

Table 13: Impact of selected control variables in the structural equation model

Path (research hypothesis)	Path coeff.	R^2 change	t-value (based on bootstrapping)	Df*	p (2-tailed level)
Industry → Commercialization activities	0.150	0.026	0.901	499	0.368
Size → Commercialization activities	-0.184		0.974	499	0.331

Notes: *Determined as the number of bootstrapping samples minus 1 (Sosik et al., 2009).

Source: High-tech SME survey. 2012 (n=105); own calculations in *smartPLS* using *Bootstrapping* (based on 500 samples).

2.4 Discussion and implications of the results

2.4.1 Theoretical implications

The results show that I have constructed a working model of the antecedents of commercialization enablers of high-tech SMEs. My SEM results, in particular, confirm that there is a strong and positive link between innovativeness and commercialization enablers in high-tech SMEs. In relation to the theory of the firm, my results show a much higher impact of internal factors on innovation activities of high-tech SMEs vis-a-vis the impact of external factors on high-tech SMEs' innovativeness. This is consistent with the resource-based view of the firm and the pecking order theory of the firm where SMEs seem to be first-and-foremost limited by a lack of internal resources (Mörec & Rašković, 2011), and also constrained by external and institutional factors (Radas & Božić, 2009).

Secondly, looking at the impact of the two modelled open innovation practices, only open innovation collaboration has a positive and statistically significant impact (γ=0.17, p=0.021) on high-tech SMEs' innovativeness and thus can be seen as an antecedent to commercialization enablers of high-tech SMEs. This shows that high-tech SMEs which

engage in broader types of open collaboration display higher levels of innovativeness which also leads to a higher commercialization propensity. This seems to be consistent with the so called collaborative paradigm but in addition shows the explicit mechanism through innovativeness.

On the other hand, the absence of a significant relationship between open innovation information exchange and innovation activities might seem surprising at first sight, since the primary motivation behind embracing (open) innovation in high tech SMEs is the focus on inside-out, commercially-oriented activities (Rhee et al., 2010; van De Vrande et al., 2009). Aside from contributing this surprising result to the limitations of my dataset (see next section), two possible explanations for this missing link may be found in Laursen & Salter's (2006) distinction between the breadth and depth of exchanging information as part of their "search strategies" (p. 131) in open innovation. First, my construct of open innovation information exchange captured just the breadth aspect of open information exchange which may not be the key dimension which impacts innovation activities of high-tech SMEs. More realistically, it may actually be the depth (quality) dimension which positively impacts specific innovation activities. Second, Laursen & Salter's (2006) breadth-depth conceptualization of open innovation builds on the premise of high-tech SMEs proactively searching external inputs for their innovation processes. A lack of a significant impact of open innovation information exchange on innovation activities of high-tech SMEs in Slovenia may, on the other hand, also indicate the reactive and market-oriented, rather than proactive and market-constructing nature of Slovenian high-tech SMEs. Prior empirical evidence by Rašković, Pustovrh & Jaklič (2012) seems to support this perspective.

2.4.2 Implications for policy making

As I will show in Chapter 3, open innovation firmly supports the notion that government intervention in supporting innovation activities is justified. It argues that linkages between actors serve as channels for knowledge diffusion and recombination and therefore increases the value of the knowledge that is created. Lack of linkages and networking across organizational boundaries represents a system failure, as do lock-ins to specific collaboration partners, sources of ideas and information or excessive overall "closure" of the learning processes (Herstad et al., 2010). These failures need to be tackled with policy intervention which creates first-and-foremost a pragmatic enabling environment (Woolthuis et al., 2005).

In order to help develop high-tech industries, policy-makers should help innovative high-tech companies collaborate with other companies in order to boost their innovation capabilities as well as commercialization activities. They should actively support SME's innovation and collaboration (linkages) in order to support their development. Some studies even see lack of government support as one of the major hurdles for their

innovation (Tsangari & Vrontis, 2012). My findings support public policy measures aimed at embracing open innovation practices in SME's since it has the potential to help them grow. For high-tech SME's, openness can lead to innovativeness and better commercialization.

Unfortunately, the support to the companies in our sample seems to have been focused on innovation activities rather than commercialization enablers. In addition, the nature of national innovation policy limits collaboration and even information exchange to a national context. However, in the newly globalized world, limiting public support to the national context can redirect information exchange and linkages to within national borders, thus 'closing' government support for open innovation.

National innovation policy in the context of a small open transition economy is especially useful as national innovation policies have been forced to take into account the drawbacks of a small domestic market (for products, services, IP and human resources). But it should be focused on commercialization and on open collaboration across national boundaries. In fact, it should aim to attract innovative ecosystems and innovation networks to locate their international hubs in a particular country and to facilitate embedding in foreign innovation networks. In that way, they should aim to connect regional and national innovation systems.

Slovenia was among the first EU transition economies to develop a specific national innovation strategy and to invest heavily in innovation policy (MVZT, 2011). This has resulted in its improved standing according to the Innovation Union Scoreboard where it advanced from 'innovation follower' to 'innovation challenger' (EU, 2012). Additionally, 99 % of all companies in Slovenia are SME's and a large share of those are innovative (Rašković, Pustovrh, Jaklič, & Brenčič, 2011). As such, it represents a case study for other transition economies in the EU. Unfortunately, the innovation policy and significant monetary support did not force the companies to focus on commercialization enabling. Even worse, it did not facilitate their international collaboration. Instead, the support is focused on collaboration inside national borders. In this way, a lot of money has been spent on innovation with relatively limited results in the form of commercial success.

We discuss more implications on policy making in the next two chapters.

2.5 Limitations and future research

The first set of research limitations is connected to the size and characteristics of our sample of high-tech SMEs. With regards to the former, one has to take into account the small size of Slovenia's SME sector in general and the limited number of high-tech SMEs in particular, especially high-tech manufacturing SMEs. With regards to the latter, a small response rate, related to high-tech KIS SMEs may also be connected to the limitations of

using Eurostat and OECD criteria for the identification of high-tech SMEs (sectorial affiliation). Following their guidelines, high-tech SMEs were chosen based on their alleged and inherent innovativeness of belonging to a particular "high-tech" sector. However, the definition of high technology is troubling (Eurostat, 2009) and excludes enterprises which belong to other sectors, but could still be very innovative. It would make sense to find a better definition of innovative SMEs and focus on their commercialization activities, even if they are not high-tech. However, I did not pursue this option in order not to lose the international comparability of my results. I strongly believe that future research should explore an alternative approach and try to identify SMEs across every sector which can be considered high-tech vis-a-vis an average sectorial benchmark (e.g. mean added value per employee or percent of workforce with a scientific or advanced degree).

The second set of my research limitations may be seen in testing only two specific open innovation practices. Despite including two of the most fundamental open innovation practices which I believe to be crucial to SMEs in particular, namely information exchange and external collaboration, other practices and activities should also be considered in the future. For example, more research should be conducted on researching the effects of other open innovation activities like licensing, spin-offs and joint-ventures, as well as buying IP in terms of high-tech SMEs' commercialization activities.

The third set of my research limitations is connected to the way that I have operationalized specific constructs in my model. In this regard, I once again have to point out that I have taken a very broad and self-reported approach to measuring the commercialization activities of our high-tech SMEs. However, I believe that such an approach is more appropriate for SMEs since it more realistically measures their commercialization "mindset" and propensity. Using more elaborative and quantitative criteria for the commercialization of innovation did not work when applied to Slovenian high-tech SMEs in the past.

Additionally, I cannot directly draw causal conclusions because the data gathered are cross-sectional. I believe that my research has opened a black box of innovativeness in high-tech SME's. The results of this study will represent the foundation to form and test specific causal relationships. Other research designs such as quasi-experimental or longitudinal studies should be conducted in the future to test the relationships posited here in a causal context.

Lastly, my data was gathered using a single respondent approach, which was deemed as better than using a number of less informed respondents (Kalmi & Sweins, 2010). This is in spite of the fact that single respondents can introduce single respondent bias. However, one also has to note that in high-tech SMEs it is quite normal for a single person to be actually in charge of innovation (mean size within my sample was just 17 employees) and this person was specifically addressed with the questionnaire. Nevertheless, I have

employed the so called Harman's single-factor test for common method bias effects which did not indicate common method variance (the first factor explained less than 25 % of the variance of the original items).

2.6 Conclusion

My research has been strongly motivated by the call for more focused research related to open innovation within high-tech SMEs set out by Chesbrough (2003) and van de Vrande et al. (2009). I have responded to this call. In particular, I aimed to fill an even greater empirical void on this topic related to high-tech SMEs from transition and post-transition economies in Eastern Europe. Acknowledging some limitations of my research I was still able to develop a working SEM of antecedents of commercialization enablers of high-tech SMEs which integrated both the traditional internal-external determinants' perspective of high-tech SME innovativeness (e.g. Radas & Božić, 2009) with a focus on the role of specific open innovation practices in high-tech SMEs (van de Vrande, 2009). In providing answers to my first two research questions, I can say that in addition to internal and external factors, open innovation collaboration – as a specific open innovation practice – is a significant antecedent to commercialization enablers of high-tech SMEs which are in the case of my data strongly determined by high-tech SMEs innovativeness. This shows that commercialization is not just directly connected to open innovation, but outlines a clear mechanism of action (impact through innovativeness).

CHAPTER 3: NATIONAL INNOVATION POLICIES IN THE EUROPEAN UNION: A FUZZY SET ANALYSIS

As I have shown in the previous chapter, embracing open innovation practices improves innovativeness of small and medium-sized companies as well as their commercialization enablers. This insight has clear implications for their growth strategies. However, I suggest a second, less direct effect open innovation has on their growth strategies – through implications on the environment they operate in. Open innovation has well recognized implications on innovation policies (Herstad et al., 2010). In this chapter, I show that two sets of innovation policies (policy measures targeting linkages and entrepreneurship) are influencing open innovation practices used by SME's to facilitate their growth. Using new research methods, I test if both sets of (open) innovation policies are really necessary for national innovation success. If confirmed, this will show that innovation policy measures that facilitate open innovation practices in SMEs help them grow by creating an environment supporting their growth strategies.

National innovation policies are considered to be one of the most important economic development policies governments have at their disposal. Research on the remarkable economic progress in some countries, sometimes described as economic miracles, cite government innovation policies as a major factor of success – for example, in Taiwan (Kraemer, Gurbaxani, & King, 1992). National innovation policy is considered especially relevant for small, developing economies as a part of their adjustments to the changing international, economic and technological order as well as for improvements to their own economic and technological situations (Lin, Shen, & Chou, 2010b). The question is, what kind of national innovation policies should be implemented in the context of open innovation.

The foundations of innovation policy-making research lie in scholarly research on innovation. In the past 10 years, innovation research has seen significant changes with the increased focus on new innovation concepts like user-led innovation (von Hippel, 1986, 2005) and open innovation (Chesbrough, 2003). These new concepts have profound effects on innovation policy-making. Their main insight is that the success of innovation policies lies in the recognition of the importance of linkages between actors in innovation systems and of entrepreneurship to commercialise innovation (Herstad et al., 2010). Linkages serve as channels for knowledge diffusion and recombination and also facilitate its commercialisation. Entrepreneurship is crucial for commercial success in a world of open innovation (Chesbrough, 2003) as open innovation influences the development of new, open business models (Chesbrough, 2006).

However, new innovation concepts also influence the need to develop new methods for innovation policy research. Innovation policy studies have mainly used traditional

statistical research methods for testing their hypotheses. But the use of correlation-based statistical methods is not appropriate for testing due to the causally complex nature of innovation policies. There is strong evidence that methods such as set-theoretic methods could be more suitable (Schneider & Wagemann, 2012, p. 89). I will demonstrate the use of a typical set-theoretic method called fuzzy-set qualitative comparative analysis (fsQCA) for evaluating innovation policy measures, especially the importance of Linkages & entrepreneurship for innovation policy success. More often used in sociology, this method is well suited to the field of policy research (Rihoux & Grimm, 2006).

The intended contribution of the chapter is to demonstrate new methods for the analysis of innovation policies that might lead to different policy recommendations. I am doing so by focusing my research on the special importance of linkages among actors and innovation commercialisation through entrepreneurship and the notion that they represent a necessary condition for innovation success. The importance of an open innovation framework for innovation policy-making will thus be emphasised.

3.1 Methodological and theoretical background

In this chapter I look at the individual conditions and their interactions for the success of national innovation policies. I focus on several conditions that are needed for their success and test their necessity or sufficiency for successful innovation policy outcomes.
To do so, I first look at the current standard approaches to evaluating the success of innovation policies. There are several approaches for such evaluation, for example systemic (Arnold, 2004), evolutionary (Nill & Kemp, 2009) and participatory (Diez, 2001). There are also some good examples of innovation policies evaluations (e.g. *OECD Reviews of Innovation Policy: Slovenia*, 2012).

During the last few years, an increased number of policy analysts have been opting for multiple case-studies as a research strategy (Rihoux & Grimm, 2006). Their choice is based on the need to gather in-depth insight into the different cases and capture the complexity of the cases while still attempting to produce some level of generalisation (Ragin, 1987). However, the prevailing way of evaluating innovation policies remains over-simplified.

The prevailing way of currently evaluating innovation policies is by constructing a single composite index from a set of indicators. These indexes aggregate a large number of indicators reflecting various aspects of science, technology and related factors into a single composite index (EIU, 2009). The underlying method for constructing them is based on simple correlation statistical methods such as regression analysis.

Several examples are often used not only in professional discourse but also in scholarly analysis. In Europe, perhaps most widely used is the annual Innovation Union Scoreboard

(IUS) (Hollanders, Es-Sadki, & Commission, 2013) and its IUS Summary Index. While initially intended as a benchmarking tool, it has become the central and authoritative source for the European Commission and other EU institutions as well as national policy-making bodies (Adam, 2014). Globally, other indices such as the Global Innovation Index (published by Cornell University, INSEAD and the World Intellectual Property Organization), Bloomberg's Rankings of the most innovative countries or the Economist Intelligence Unit's Ranking of the world's most innovative countries are comprised and publicised.

Methodologically, such approaches are weak. The underlying assumption of such methods is that a higher score on each individual indicator implies better innovation performance. Every improvement of each individual indicator will lead to better innovation performance. This represents a clear example of causal simplicity where researchers focus on linear additive effects of single variables independent of any other causal factors (Schneider & Wagemann, 2012). However, there are good reasons to believe that the phenomenon of successful innovation policy is more complicated than that. Innovations can be explained in a multi-causal manner. (Edquist, 2001, p. 11).

Acknowledging the weaknesses of the prevailing approach, OECD publishes its bi-annual OECD Science, Technology and Innovation Scoreboard (*OECD Science, Technology and Industry Scoreboard*, 2013) as a comparative analysis. It compares member states along a set of indicators but does not try to aggregate them into a single index. Instead, it qualitatively compares innovation trends. While methodologically more sound, this approach does not tackle the issues of the role of individual innovation factors and their influence on innovation success. It also has limited generalisation use. A better method would take into account the complex nature of innovation policy as the interplay of different policy measures and evaluate individual policy measures at the same time. It would incorporate the characteristics of both qualitative and quantitative methods. The focus should lie on causality of innovation policy measures and their necessity or sufficiency for successful innovation outcomes.

We believe innovation policies have the characteristics of causal complexity (Edquist, 2001). There are three characteristics of causal complexity that are defined as equifinality, conjunctural causation and causal asymmetry.

Empirical analysis and case studies suggest that different and mutually non-exclusive innovation policies can be successful and lead to similar outcomes. For example, the United States has different innovation policies than the Scandinavian countries, and even more different yet are those of South Korea. However, they are all considered successful innovators. They all have high IUS Summary Index scores even though their policy mixes are substantially different. The EU offers some tools to compare innovation policy

measures for each country in its Joint Inventory of Policy Measures,[5] which shows the variety of different policy measures national policy-makers implement, even though they often reach very similar innovation success (measured by the IUS Summary Index or by other measurements). In another example, the IUS Summary Index scores for Ireland and the United Kingdom in 2013 are virtually equal at 0.61, even though their corresponding policy mixes are quite different. This is an example of equifinality.
Additionally, there is clear evidence that single policies can unfold only in combination with other precisely specified conditions. An example is a policy measure to support the establishment of a venture capital (VC) industry to help support the commercialisation of technologies. The case study of a very successful government intervention by the Israeli government in 1990s (the Yozma instrument) has been replicated by a number of countries but with much less success – for example Slovenia and Croatia (Švarc, 2006); neither Slovenia nor Croatia experienced such successful development of their respective VC industries as was observed in Israel. The reason for the lack of success probably lies in a lack of other conjunct policy measures – for example, the technology-transfer mechanisms and structure in Israel that were significantly different than those in EU countries. This is an example of conjunctural causation.

Finally, policies that lead to innovation success are not the same as the (lack of) policies leading to innovation failure. It is an over-simplification to claim that a lack of innovation success is the result of lacking innovation policies that were sufficient to lead to innovation success in other countries. If this were sufficient for innovation success, all the countries would copy successful policies, and soon after they would become successful themselves. In reality, implementing exactly the same innovation policies that were successful in Israel will not turn a country like Slovenia into a leading venture capital provider, just as the lack of a developed venture capital industry is not the only culprit of less successful innovation outcomes. Causal conditions leading to the presence of successful innovation outcomes are of only limited use for the causal role of its absence. This is an example of causal asymmetry.

Statistical regression-based methods cannot achieve causally complex results, as they cannot unravel set relations and the form of causal complexity that comes with it. For example, correlation is a symmetric measure in the sense that if I am able to explain the positive or high values of a dependant variable, then I am also able to explain the negative or low values of the dependent variable (Schneider & Wagemann, 2012). In contrast, asymmetric set relations indicate set-theoretic relations such as sufficiency and necessity. Asymmetry describes the fact that insights into the causal role of a condition are of limited use for the causal role of its absence. The explanation of the occurrence of the outcome does not necessarily help us explain its non-occurrence.

[5] Available at http://erawatch.jrc.ec.europa.eu/erawatch/opencms/research_and_innovation/

Data patterns of correlation also look quite different from those of a set relation. It is absolutely possible for a researcher to find a perfect set relation but fail to detect any strong correlation between the variables. Correlational methods rely on both the presence of conditions (variables) at the same time as the presence of the outcome and their absence. They have equal analytic relevance. On the contrary, set-theoretic methods look at cases where both conditions and outcomes are absent as irrelevant for explaining the causation. They should be analysed by developing another set-theoretic model with a new, negated outcome. The conditions influencing the presence of an outcome (in this case innovation success) are not the same as the conditions influencing its absence. Set-theoretic models incorporate this asymmetry, while correlation-based models are inherently symmetrical. Methods like ordinary least squares in which the sum of the square roots of distances between dots and regression line are minimised are a direct expression of this symmetry (Schneider & Wagemann, 2012, p. 84).

Methodologically induced assumptions of simplicity run the risk of generating oversimplified representations that are very much detached from the cases and data patterns that underlie the analysis of innovation policies. They do not correspond to the complexity of the social world and lead to wrong policy recommendations and a waste of resources.

3.1.1 Set-theoretic methods are more suitable for researching causal complexity

As correlational statistical methods cannot achieve causally complex results, they are not suitable for researching causally complex phenomena. Unlike conventional statistical techniques which are based on examinations of sufficiency (Ragin, 2000), set-theoretic methods can examine the links between various combinations of causal conditions and the outcome as both necessary and sufficient conditions. They can systematically and formally examine the necessary and sufficient conditions for the outcome. This is important here, as it is yet to be established whether certain innovation policy measures are either necessary and/or sufficient for countries to achieve desired innovation outputs. The use of set-theoretic methods means that causal relationships between conditions and the outcome can be explored. These findings may, in turn, lead to clearer policy implications than would be the case from an analysis of the marginal effects obtained from regression analyses (Fiss, 2011).

This chapter uses a relatively new approach of a set-theoretic method to show that other methodological approaches will yield different results and a different view on the innovation process and consequent innovation policy-making. This approach allowed for a detailed analysis of how causal conditions contribute to the outcome in question. It was based on a configurational understanding of how causes combine to bring about outcomes (Fiss, 2011, 2012). I have used the most often used set-theoretic method, called qualitative comparative analysis (QCA).

The original QCA method was developed 27 years ago (Ragin, 1987) and is based on the binary logic of Boolean algebra. Essentially, QCA examines how the membership of cases in the set of causal conditions is linked to the membership in the outcome set (Allen & Aldred, 2011). Cases are best understood as configurations of attributes. Their comparison allows a researcher to examine instances of the cause and outcome to understand patterns of causation. It uses set–subset relations to examine causal patterns of necessity and sufficiency. A condition is necessary, if, whenever the outcome is present, the condition is also present. Additionally, the condition is sufficient if, whenever the condition is present, the outcome is also present (Schneider & Wagemann, 2012, p. 76). The QCA method uses formal procedures to test the necessity and sufficiency of conditions for the outcome. In this chapter, I demonstrate the use of these procedures in innovation policy research and evaluation.[6]

An additional benefit of the QCA method is that it also attempts to maximise the number of comparisons that can be made across the limited number cases under investigation. The technique aims to resolve the problem of a small number of case observations by allowing inferences to be drawn from the maximum number of comparisons that can be made across the case under analysis. As such, it is particularly useful when analysing country comparisons as their numbers are inherently small but at the same time too high for the use of other qualitative methods such as case studies.

The original QCA method was based on crisp values of 1 indicating the presence of a particular set and 0 indicating its absence (Ragin, 2007). Due to its binary logic, this method is today known as a crisp-set QCA (csQCA) and has been criticised, as the researcher has to determine the values of each variable. But as most variables are essentially continuous, the division will always be arbitrary. A second, related problem is the fact that the technique does not allow an assessment of the effect of the relative strengths of the independent variables (as they can only have two values). In order to avoid these problems, the QCA method was upgraded with fuzzy-set theory to address partial memberships in the set (Ragin & Rihoux, 2009). This fits well with innovation policy research as individual innovation policy indicators are often normalised and based on a continuous scale. On the other hand, fuzzy-sets are a powerful tool that allows researchers to calibrate partial membership in sets without abandoning the core set-theoretic principles (such as subset relations). They are at the same time qualitative and quantitative as they incorporate both kinds of distinctions in the calibration of the degree of set membership (Ragin & Rihoux, 2009).

[6] For an excellent introduction into QCA methods, its theory and procedures, the reader is referred to Schneider and Wagemann, 2012.

Based on this reasoning, I have used a set-theoretic method of fuzzy-set qualitative comparative analysis (fsQCA) to test innovation policy measures. Specifically, I have used fsQCA to analyse the causal complexity of innovation policies, aiming to assess the relationship between combinations of 'causal conditions' and the related output (Ragin & Rihoux, 2009). I demonstrate this analysis based on an idea originating from the open innovation paradigm.

3.1.2 Open innovation and its influence on innovation policy-making

The theoretical background of this chapter is the premise that innovation is not a closed system but rather is dependent of the extent of mutual cooperation. Innovation policies need to take this into account and not focus solely on supporting individual companies but on their collaboration as well. This premise is central to the open innovation paradigm (Chesbrough, 2012). It assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology.

The implications of open innovation systems on innovation policies have been predicted and studied since the definition of the concept. One of the open innovation's main arguments is that linkages between actors serve as channels for knowledge diffusion and recombination. Lack of linkages and networking across organisational boundaries represents a system failure, as do lock-ins to specific collaboration partners, sources of ideas and information or an excessive overall 'closure' of learning processes (Herstad et al., 2010). These failures need to be tackled in a way similar to market failures – through policy intervention (Woolthuis et al., 2005). Recently, several papers and studies discussed the question of how national innovation polices can be reframed in a context of open innovation (De Backer et al., 2008; Ebersberger et al., 2011).

The central idea behind open innovation is that, in a world of widely distributed knowledge, companies cannot afford to rely entirely on their own research but should instead buy or license processes or inventions (i.e. patents) from other companies. In addition, internal inventions not being used in a firm's business should be taken outside the company (e.g. through licensing, joint ventures or spin-offs) (Chesbrough, 2003). In other words, linkages between companies and other institutions are crucial for the successful implementation of innovation in companies. However, innovation itself is only one part of the process – the value creation part. To ensure commercial success, companies also need to capture the newly created value. Claiming ownership of the intellectual property for newly developed technologies and finding different paths to the market are also crucial parts of the open innovation concept (Chesbrough, 2006). This means that companies of all sizes can create and capture value from ideas and technologies. Open innovation is becoming increasingly relevant to entrepreneurs and the organisations that support them. This second part of the open innovation concept essentially emphasises entrepreneurship

and the importance of business ecosystems for established companies and start-ups (Mcphee & Segers, 2013). Without successful linkages between different innovation actors, there can be no successful innovation and thus no value creation. Without successful entrepreneurs, positioned in a vibrant business ecosystem, there can be no value captured from successful innovation. Both are necessary for a successful national innovation system.
National innovation policies have already started to adjust to the recent changes. Some successful examples include Ireland (Irish Innovation Taskforce, 2010), Taiwan (Lin et al., 2010b) and the US (Technology, 2010). On the contrary, innovation policies that do not adjust to open innovation will not be successful (Švarc, 2006). Far from becoming redundant, innovation policies remain an essential element of industrial policy.

Based on the insights contributed by the new innovation concept of open innovation, I will use an example of Linkages & entrepreneurship, as defined in an open innovation framework, and demonstrate that they are a necessary condition for the success of innovation policies.

Hypothesis 3.1*: Linkages & entrepreneurship are a necessary condition for the success of national innovation policies.*

The use of a novel research method has allowed us to test not only for the necessity but also for the sufficiency of Linkages & entrepreneurship as well as other conditions for innovation success. I discuss these conditions in more detail below.

3.2 Data and methods

Using fsQCA, this research has focused on analysing different innovation policies in the EU. The EU has recognised the importance of specific policies that focus on improving innovation outcomes – the 'narrow' innovation policies – in order to improve its growth prospects in the newly globalised environment. It recognised it cannot compete in this new environment unless it became more innovative (Commission, 2013a). The main current EU innovation policy is the Innovation Union, one of the Europe 2020 growth strategy's flagship initiatives (Commission, 2013c). Its aim is to set out a strategic approach to innovation, seeking to boost research and innovation performance in Europe by getting promising ideas and discoveries to the market faster. A crucial part of this approach is building 'bridges' connecting science, technology and markets (Commission, 2013b).

An integral part of the Innovation Union is the annual IUS assessment. It provides a comparative assessment of the research and innovation performance of the EU27 Member States and the relative strengths and weaknesses of their research and innovation systems. It has become the benchmark for innovation policy evaluation in the EU and helps member states assess areas in which they need to concentrate their efforts in order to boost their

innovation performance (Hollanders et al., 2013). The calculation of the annual composite IUS Summary Innovation Index allows the preparations of country rankings and assures considerable publicity in the media and in the interested public (Schibany & Streicher, 2008). This is also likely one of the most important results of the IUS initiative which has assured its continuation into its 14th year.

However, there is also considerable criticism of this approach. New understanding of innovation processes has resulted in changes to the IUS reports and indicator selection. Particularly, the constructs of user innovation and open innovation and the emergence of service innovation have influenced the selection of indicators that comprise the composite index. However, this selection has been limited due to lack of new data as IUS indicators are based on official statistical sources. It also strongly relies on the Community Innovation Survey, a biannual series of harmonised surveys that are executed by the national statistical offices throughout the EU. Lack of sufficient data has certainly influenced the indicator selection, but the overall criticism was more directed at the arbitrary selection of indicators, which is not based on an underlying model of innovation. For example, a methodological review of IUS, implemented by the authors themselves an IUS methodological review themselves (Hollanders & van Cruysen, 2008) lists a number critics, including Rammer (2005) who states that "new indicators should be identified and selected on . . . a conceptual analysis rather than on a simple statistical correlation analysis".

Among other things this has resulted in apparent high-tech bias. Furthermore, the indicators should focus on questions of data quality, including reliability as well as availability for large number of countries. The link between indicators and policies should distinguish between performance indicators and policy indictors. As Schibany (2008) noted, "Any concise inference regarding the selection of indicators and . . . their mutual interaction is mostly ignored". Additional methodological criticism emphasised the drawbacks of the construction of a single composite indicator, missing the complexity of the innovation process (Cherchye, Moesen, & Van Puyenbroeck, 2004). The low quality of data also raises significant issues of multicolinearity between indicators. Multicolinearity between indicators is a typical problem originating from the statistical method used for the construction of the composite IUS Summary. As discussed above, using correlation statistical methods for causally complex phenomena (like innovation policies) is not recommended (Schneider & Wagemann, 2012).

3.2.1 Operationalization of the qualitative comparative analysis

To perform the fsQCA analysis of the innovation policies, I proceeded along the steps presented in the table below.

Table 14: Steps taken in the qualitative comparative analysis

Step	Description
1	Compilation of a database of existing indicators on innovation policies in the EU.
2	Calibration of indicators and their conversion to (fuzzy) set membership scores.
3	The construction of the truth table – a data matrix wherein each row of the table is associated with a special and distinct combination of attributes, and the full table consists of all possible combinations of attributes. All empirical cases were sorted into the rows of the truth table.
4	Analysis of necessary conditions
5	Analysis of sufficiency using the truth table algorithm: minimisation of the truth table by reducing the number of rows based on the minimum number of cases required for the solution and the minimum consistency level of a solution (consistency meaning the degree to which cases correspond to the set-theoretic relationships expressed in a solution).
6	Obtained three solutions following the Standard Analysis procedure to minimise the truth table – complex, parsimonious and intermediate. Based on the simplifying assumptions, I've used an intermediate solution to interpret the results.

To execute the QCA procedure,I used the fs/QCA software (Ragin, Kriss, & Davey, 2006; available at www.fsqca.com).

3.2.2 Dataset of innovation policy indicators

First, I've compiled a database of existing indicators. In order to demonstrate the differences between correlational statistical methods and set-theoretic methods, I used the same data as in the original IUS. By using the same underlying data but obtaining different results, I intended to demonstrate differences between methods. This means that I needed to test the same innovation inputs into innovation activities and the activities themselves (defined as innovation enablers and innovation activities in the IUS) that were tested in the original IUS summary index. The data on human resources, research systems, finance and

support, firm investments into research and innovation and Linkages & entrepreneurship were obtained by using the IUS data.

I used the existing dataset of IUS indicators IUS (EU, 2012). In the IUS, these measures were split into two groups of indicators:

Table 15: Indicators used for the formation of the dataset

Innovation enablers	
Human resources index	Summary index comprised of three indicators: new doctoral graduates, population with completed tertiary education and youth with upper secondary level education
Open, excellent and attractive research systems	Three indicators on international scientific co-publications, scientific publications among the top 10% most cited and non-EU doctoral students
Finance and support	Two indicators on public research and development [R&D] expenditure and on VC financing
Firm activities	
Firm investments	Two indicators on business R&D expenditure and non-R&D innovation expenditure
Linkages & entrepreneurship	Three indicators on [SMEs] innovating in-house, innovative SMEs collaborating with others and public–private co-publications
Intellectual Assets	Four indicators on Patent Cooperation Treaty [PCT] patent applications, PCT patent applications in societal challenges, community trademarks and community designs

Source: Innovation Union Scoreboard 2012

All indicators used were defined in the same way as in the original IUS. That means they are based on a set of indicators measuring the success of national innovation policies for each particular condition rather than measuring concrete activities on the level of companies.

As my hypothesis was focused specifically on Linkages & entrepreneurship, I could see that the composite indicators are comprised of internal SME innovation, SME innovation

linkages and general science and innovation linkages. While more and better indicators on Linkages & entrepreneurship would be desirable, I have used the existing composite index in order to demonstrate the new research method and its benefits in innovation policy research. The IUS is also very useful as it collects a large database of innovation indicators and innovation policy measures that can be used for analysis with methods other than the IUS Summary Index.

While IUS data are available for more than 50 countries, I was primarily interested in identifying differences between the countries of the EU or those closely connected to them (usually in membership talks or in special arrangements with the EU). This assured relatively similar institutional and regulatory backgrounds, and, to a lesser extent, cultural backgrounds. Thus, I could assume that the differences in the innovation output of countries were the result of innovation policies and not differences in framework policies or the different institutional structures of individual countries. In the end, I've used the dataset for 23 countries.

I used the average value for the period between 2007 and 2009 for my indicators. I did not use the indicators for measuring economic effects and innovators as the authors of the index classified them as measures of innovation output. My research design meant that I needed to use a different measure of innovation output – the (aggregate) IUS Summary Index itself.

3.2.3 Data calibration

In order to operationalize my research, I constructed fuzzy-set scores for each indicator and for the output of each country based on four-item scale. The QCA analysis would normally request its own calibration thresholds for the data; however, in this case, the aim of the research was the analysis of IUS data. They are already normalised, so it would be against the aim of the research to devise different measures than the ones originally used in the IUS. For the same reasons, it would be unreasonable to use any other set-theoretic method than fsQCA as individual cases (countries) have already obtained index scores spanning the full range between 0 and 1.

The IUS reporting had delineated countries into four groups. The Summary Innovation Index score of Innovation leaders is 20% or more above that of the EU27; of Innovation followers, it is less than 20% above but more than 10% below that of the EU27; of Moderate innovators, it is less than 10% below but more than 50% below that of the EU27; and for Modest innovators, it is below 50% that of the EU27. These thresholds were used for the direct calibration of the data and their subsequent grouping into one for the four groups that were given the same fuzzy score. For example, the EU's average Summary Innovation Index score for 2010 was 0.53– 120% of that was 0.64, 9% value was 0.48 and 50% value was 0.27. These values were used as the three points for the direct method of

calibration and the thresholds for the groups that were given the same fuzzy score. All countries with an IUS Summary Index score higher than 0.64 were given the fuzzy score of one, those between 0.64 and 0.48 were given a fuzzy score of 0.66 etc. I decided to use the same calibration for IUS factors (composite indicators, conditions in the QCA analysis) as well.

3.2.4 Analysis of necessity

We started the data analysis with the analysis of necessary conditions for the presence of the outcome using the formal QCA procedures. The results of this analysis implied that the Linkages & entrepreneurship fulfil the criteria for a necessary condition for the outcome IUS as they had a very high consistency of almost 0.98 (they also had high coverage). This result was confirmed by the XY plot for the variable of Linkages & entrepreneurship as it showed a high probability of necessity of this condition with a single observation (Spain) visible above the bisecting line and all others lying below the line as expected to fulfil the criteria of necessity (whenever the outcome is present, the condition is also present). This confirmed my central hypothesis that this condition is necessary. The formal procedure conducted on the analysis of necessity did not show any other necessary conditions.

3.2.5 Analysis of sufficiency – The truth table algorithm

We proceeded with the formal analysis of sufficiency. The XY plots also suggested that Finance and support could be a sufficient condition by itself. However, further examination showed that three cases (Estonia, Norway and France) lay below the bisecting line, thus breaking the rule for sufficiency (whenever the condition is present, the outcome is also present). These cases will be noted for further examination when analysing the results.

We proceeded with the truth table algorithm. After hiding the logical reminder rows (in this case, rows with no recorded cases), I've coded the outcome with 1 if the raw consistency was above 0.99. This threshold was not only theoretically sound, but it was also marked with a clear break in the consistency values as the next row had a low consistency score of 0.83 and a relatively low PRI consistency score – potentially implying that this sufficiency condition could also be the sufficiency condition of the negated outcome ~Y. The truth table thus obtained is presented in Table 16:

Table 16: Fuzzy-set truth table

A	B	C	D	E	F	Number of cases	Y	Raw consist-ency	PRI consist-ency
1	1	1	1	1	1	**8**	1	*1*	*1*
1	1	0	1	1	0	**1**	1	*1*	*1*
1	1	1	0	1	1	**3**	1	*1*	*1*
1	1	0	1	1	1	**1**	1	*1*	*1*
1	0	0	1	1	0	**1**	1	*1*	*1*
0	0	1	1	1	0	**1**	1	*0.99*	*0.97*
1	1	1	0	1	0	**1**	0	*0.83*	*0.75*
0	0	0	1	1	0	**1**	0	*0.8*	*0*
0	1	0	0	0	0	**1**	0	*0.75*	*0*
0	0	0	1	0	1	**1**	0	*0.67*	*0*
0	0	0	0	1	0	**1**	0	*0.6*	*0*
0	0	0	0	0	0	**1**	0	*0.43*	*0*
0	0	0	1	0	0	**2**	0	*0.37*	*0*
1	0	0	0	0	0	**1**	0	*0.25*	*0*

**Notes: ****The consistency threshold of 0.85 was used due to low PRI scores in truth table rows 7 and 8*
******** *Written in Boolean algebra:*
*(A*B*C*D*E*F)+(A*B*~C*D*E*~F)+(A*B*C*~D*E*F)+*
*(A*B*~C*D*E*F)+(A*~B*~C*D*E*~F)+(~A*~B*C*D*E*F)=Y where*
A= hr_c= Human resources
B= rs_c= Open, excellent and attractive research systems
C= fs_c= Finance and support
D= fi_c= Firm investments
E= la_c = Linkages & entrepreneurship
F= ia_c = Intellectual assets
Y (outcome) = IUS = Innovation Union Scoreboard innovation performance score

3.2.6 Logical minimisation procedure

Three solutions were obtained from the truth table using the Standard Analysis procedure.

Complex solution:
(A*~C*D*E*~F)+(A*B*C*E*F)+(~A*~B*C*D*E*~F)*(A*B*~C*D*E)+(A*B*D*E*F)
=Y
Parsimonious solution: (A*D)+(C*D)+(A*F)+(B*F)+(C*F)+(E*F)=Y
Intermediate solution: (E*D*C)+(E*D*A)+(F*E*C*B*A)=Y ;
E*((D*C)+(D*A)+(F*C*B*A))=Y

We decided to use the intermediate solution as the best one for further analysis as it was based on the most plausible, theory-based assumptions for logical reminders. These assumptions were based on easy counterfactuals and are normal in the Standard Analysis as part of the QCA procedure. Both methods are part of the Standard Analysis procedure and are essentially mathematical tools that enable us to obtain useful solutions from a limited number of cases.

The simplifying assumptions that were used were directional expectations and prime implicants. The directional expectation used presumed that the presence of each individual condition would have a positive effect on the presence of the outcome based on a sound theoretical background. Prime implicants had to be used as a mathematical tool in the logical minimisation procedure due to limited diversity. I have marked four prime implicants (A*F, B*F, C*F and E*F) to obtain the intermediate solution, indicating that different combinations of conditions combined with the condition of F (Intellectual Assets) were used to obtain the solution.

3.3 Results

Our chosen solution has recognised three paths to a successful IUS Summary Index:

E*((D*C)+(D*A)+(F*C*B*A))=Y or
Linkages & entrepreneurship AND
((Finance and support AND Firm investments) OR (Firm investments AND Human resources) OR (Human resources AND Open, excellent and attractive research systems AND Finance and support AND Intellectual assets))
lead to the presence of the outcome (innovation success, measured as a high IUS Summary Index Score).

Table 17 presents the analysis of sufficient conditions and parameters of fit for the outcome of ‘Innovation Union Summary Index success’.

Table 17: Analysis of sufficiency conditions

Solution	**E*D*C**	**+**	**E*D*A**	**+**	**F*E*C*B*A**
Single country coverage	Estonia		Ireland, Austria, Slovenia		France, Netherlands
Consistency	0.96		1.00		1.00
Raw coverage	0.58		0.62		0.55
Unique coverage	0.07		0.11		0.07
Solution consistency	0.971				
Solution coverage	0.753				

Notes: *
A= hr_c= Human resources
B= rs_c= Open, excellent and attractive research systems
C= fs_c= Finance and support
D= fi_c= Firm investments
E= la_c = Linkages & entrepreneurship = ***necessary condition (present in all sufficient conditions)***
F= ia_c = Intellectual assets
*** Finland, Sweden, Switzerland, Belgium, Denmark, Germany, Luxembourg and the UK were covered by more than one combination.*

The analysis of sufficient conditions showed that the condition of Linkages & entrepreneurship was confirmed to be the only sufficient condition present in all solution paths to IUS success. This re-confirmed my original hypothesis that the condition of Linkages & entrepreneurship is necessary for innovation success (measured by a high IUS score).

The results also showed three combinations of sufficient conditions that lead to the presence of the outcome. So, while no individual condition is sufficient for high a IUS score, there are three combinations of sufficient conditions that are adequate.

3.3.1 Analysis of the robustness of results

In order to test the robustness of the three solution paths, I repeated the QCA procedure with small changes to the data calibration process and small changes to the raw consistency value. Both methods showed that my results were relatively robust. In most cases, using slightly different thresholds yielded relatively similar fuzzy scores, as there were clear breaks in the original data, emphasised by the direct method of calibration.

Similarly, in order to test the robustness of the truth table, I also tried to use the raw consistency threshold for the presence of the outcome of 0.8, as is often the standard in

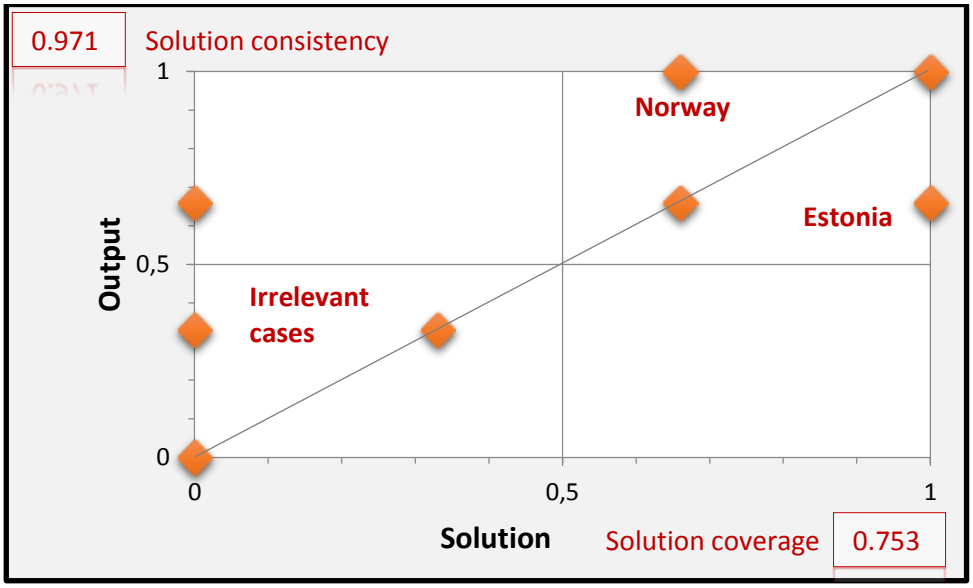
fsQCA analysis. It became obvious that a truth table obtained in this way has a significant problem. While consistency scores for rows 7 and 8 were higher than 0.8, their PRI scores were low – even 0 in the case of row 8. This showed that both sufficiency conditions are possibly also sufficiency conditions for the negated outcome ~Y. For that reason I decided to increase the consistency threshold to 0.99, where another clear break in the data assured no problems with the PRI scores. Thus, I've obtained the original truth table presented above. Small changes to the consistency threshold of 0.99 did not change the structure of the truth table and had no effect on the results. My results proved to be quite robust according to standard tests of robustness.

However, one problem with my QCA procedure was that it required a large number of prime implicants. This implied that I might have issues with limited diversity. In this case, I had only 23 observations (countries), but I had six conditions – meaning that there are 64 different combinations of conditions. Unfortunately, all the observations in my dataset have only filled 14 truth table rows, resulting in 50 logical reminders. It would help greatly if there were more observations and fewer logical reminders, so I plan to improve the dataset in the future with additional cases that will add to the variability. Nevertheless, there are no indications that additional observations would lead to significantly different solution paths. I therefore conclude that the results are quite robust.

3.3.2 Assessment of the quality of the results

While I obtained relatively robust results, they could still be of low quality in terms of explaining the actual cases of the countries. Luckily, the QCA analysis allowed us to formally test the quality of the solution. Both solution consistency scores and solution coverage scores are relatively high. That tells us that most of the countries (cases in my analysis) fit well into the three solution paths – their output (innovation success) is well predicted within my model. The plot of the solution shows that there is an overwhelming majority of typical cases that lie on the bisecting line and several irrelevant cases with very low solution outcomes. The plot also shows a single deviant case with a high solution score but a low outcome score: Estonia. This is a deviant case in terms of consistency in degree. This could imply that some conditions could be missing in the sufficiency path to explain the case of Estonia. Estonia is thus a good target for specific analysis in the form of a case study. On the other hand, I have another outlier in the form of Norway that has a high outcome score but a low solution score. It is thus a deviant case for coverage and could imply that the entire solution path could be missing. Again, this would be a good choice for a case study (although one can imagine that sufficient oil revenue and other broad innovation factors make Norway highly attractive for innovation).

Figure 7: XY plot for the overall solution



Notes: * *Solution consistency and solution coverage are reported in the corners.*

I can conclude that my solution has relatively high coverage and consistency values and that a large majority of cases lie on the bisecting line, representing typical cases for the solution. The solution is actually quite good at explaining the different sufficiency conditions leading to innovation success.

A general observation one can also ascertain from the XY solution plot is a clear clustering of countries. With the exception of Norway, all Scandinavian countries and Switzerland are successful and have good solution scores. On the other hand, Southern European countries as well as some Eastern European countries cluster together with low outcome scores and low solution scores – in the bottom left corner – and are thus irrelevant cases. A potential explanation for this might be that their low scores could be explained by special conditions. However, the QCA analysis requires a special analysis to explain the negation of the outcome (in this case, the absence of innovation success). I continued to perform the analysis for the negation of the outcome - ~Y = low Innovation Union Scoreboard Summary Index. While not presented here due to space limitations, it does shows conditions leading to a lack of innovation success different from the ones leading to its presence. Such asymmetric results are normal for the QCA method but are not possible to obtain using correlational statistical methods.

3.4 Discussion

These results were already quite interesting for the evaluation of the methodology background of the IUS Summary Index. My QCA analysis showed that the IUS Summary Index methodology is flawed as it lies on a foundation of the probabilistic method of regression analysis. The results of this method are not to be interpreted as if they reveal set relations, necessity or sufficiency. For example, the IUS Summary Index implies that if a country aims to increase individual innovation factors (conditions in QCA analysis), this would lead to a (marginal) increase in its IUS Summary Index score. However, my analysis showed that countries with high IUS Summary Index scores have used different and often specific paths and combinations of conditions to obtain their scores. It is not necessary to have high scores in all factors to reach the outcome. Similarly, in order to improve innovation success, missing conditions can impede achievement of overall success even if countries continue to increase other factors. Single innovation policy measures can unfold only in combination with other precisely specified conditions. In my case, an increase in the *Intellectual assets* score would not improve the overall innovation success of a country like Ireland or Slovenia as sufficient conditions for their innovation success are *Human resources* and *Firm investments* (as well as the necessary condition for all innovation success of *Linkages & entrepreneurship).* This confirmed conjunctural causation – a defining characteristic of causal complexity.

Another advantage of using a set-theoretic method in my research was that it enabled potential clusters of institutional configurations and countries to be identified. If such clusters could be found, this would imply convergence tendencies among countries. Additionally, this approach could lead to an observation that several different configurations of causal conditions will be linked to the same outcome (Allen & Aldred, 2011). This is very useful for my research as it allowed us to assess whether different countries are able to reach the same objective – innovation outputs – by different means. The results of my research showed three distinct paths to the outcome, each with specific countries that use it (there are also a number of countries that use more than one path at the same time). This confirmed equifinality – another characteristic of causal complexity.

Finally, the results showed that the paths to the outcome were not the same as the paths to the negation of the outcome. Three distinct paths exist to explain the combinations of sufficient conditions that lead to the presence of the outcome, and one condition is proven to be necessary. However, while not presented in the chapter, four paths lead to the negation of the outcome and no condition is necessary. This is a clear example of causal asymmetry.

Our research showed that the phenomenon of successful innovation policy is causally complex. It also showed that the IUS Summary Index does not account for this complexity. The IUS Summary Index is inherently a correlation model. This method would be

appropriate if the innovation theory implied (and empirical evidence confirmed) that the linear additive effects of single variables independent of any other causal factor would be sufficient to explain different levels of innovation outcomes between countries. As this does not seem to be the case and innovation policies are causally complex, set-theoretic methods are a better methodological model for research on innovation policies (Schneider & Wagemann, 2012, p. 77).

This does not mean that set-theoretic methods have no limitations. They are based on data calibration that influences set memberships. In general, slight changes in the calibration could lead to significantly different results. Its use of logical reminders to obtain maximum diversity and best results is difficult and often flawed (although one can always choose to ignore the use of logical reminders and just use the complex solution that does not include logical reminders in its analysis). And initially, the method is somewhat difficult to use as its logic rests on Boolean algebra and not on the probabilistic statistical approach that most social science researchers are more familiar with. However, the use of this novel method can improve the understanding of some phenomena that 'standard' statistical methods cannot explain well. I believe that innovation policy research is such a phenomenon.

3.5 Conclusion and implications

We have identified a couple of specific countries that call for more thorough in-depth analysis in the form of case studies. My analysis identified Estonia and Norway as specific targets. Estonia has a high solution score but a low outcome score. This is a deviant case for consistency in degree. On the other hand, I have another outlier in the form of Norway, which has a high outcome score but a low solution score. It is thus a deviant case for coverage. Both cases are not well explained by the three solution paths obtained as results of the QCA procedure. They call for more in-depth analysis in the form of case studies.

The demonstration of the fsQCA procedure on my dataset also confirmed the special importance of *Linkages & entrepreneurship* as a necessary condition for innovation success. This supports the idea originating from the open innovation framework: Innovation is not a closed system but is rather dependent of the extent of mutual cooperation. A lack of linkages and networking across organisational boundaries does represent a systemic failure, as do lock-ins to specific collaboration partners, sources of ideas and information or excessive overall 'closure' of learning processes (S. J. Herstad et al., 2010). This failure needs to be tackled in a way similar to market failures – through policy intervention (Woolthuis et al., 2005). Innovation policies need to take this into account and devise policy measures that do not focus solely on supporting individual companies but on their collaboration as well.

Examples of such policies are already in place. In the EU, they include the Knowledge and Innovation Communities (KIC) of the European Institute of Innovation and Technology (EIT). They focus on the international collaboration of companies, public research organisations, universities and other actors from several EU countries in pursuit of the development of a specific technology (and creating pan-European value chains for the future). The results of these policies are measured in the IUS by public–private co-publications, innovative SMEs collaborating with others and SMEs innovating in-house. R&D collaboration (especially international) and joint entrepreneurial development of new innovations form the necessary condition for innovation success and should be targeted by national policy-makers. Another interesting example of such a policy instrument is the so-called 'innovation voucher' – successfully implemented in the US and in Israel. Companies can obtain a subsidy from the government that has to be used for obtaining innovation results (often technology or intellectual property) from public research organisations. Thus, it facilitates mutual cooperation and knowledge transfer between public research (often in the realm of basic science) and commercialisation in private companies. Both private and public stakeholders benefit from such collaboration, as does the general public due to increased societal yields of public funds invested into basic public research in the form of newly created value. While the companies capture this value, it also contributes towards financing public goods through taxes and social contributions (and often licence fees).

However, there is no single public policy supporting Linkages & entrepreneurship that will be successful in every business (eco)system. While good practice examples, as the ones mentioned above should be tried in several countries, the results of my analysis show that there are different solution paths leading to innovation success. This means that individual countries with their distinct business systems will be more inclined to try certain policies than others and will also be able to benefit more from certain policy measures than from others. This leads to the individual solution paths towards innovation success. Countries with similar business systems will develop similar solution paths, which we can observe in my results. This also means that individual countries should not blindly copy measures that work in other countries. Rather, they should test different measures and keep those that yield the best results, establishing their own solution paths. Successful innovation policy-making should be focused on establishing a platform for testing and evaluating different innovation policy measures, continuing those that are proven successful and discontinuing those that are not – replacing them with new measures to test. Such a lean policy-making approach mimics the lean approach to business development seen in start-up companies.

Our research shows that the IUS framework remains useful as it provides data for a comparative assessment of research and innovation performance, collecting a large database of innovation indicators and innovation policy measures. This makes it a useful tool for innovation research. The IUS also highlights the importance of innovation policy to policy-makers and the general public, assuring innovation policies considerable

publicity in the media and in the interested public. It has been instrumental in the preparation of the new pan-European flagship initiative called the 'Innovation Union' as part of the EU's 10-year strategy. However, the IUS Summary Index should not be recommended as a tool for innovation policy evaluation.
Finally, the results of my research revealed the specific limitations of such research approach. This research has the potential to expand its use by continuing with specific in-depth case studies, focusing on individual innovation policy measures and exploring the institutional structure and framework conditions for innovation.

Another clear limitation of this research is that it does not focus on evaluating particular and individual innovation policy measures. This was not its purpose, but such evaluation would be highly useful for a better understanding of the distinct causally complex processes that lead to innovation success. The EU, with its commonalities (shared cultural and to some extent regulatory environment) and differences in implementing national innovation policies represents a perfect laboratory for innovation policy research. There is also a sufficient amount of data gathered on EU countries, both on policy measures and their results. Further research in this direction would help explain large differences in innovation success between countries sharing so much otherwise.

Further studies on the broader innovation policies and institutional framework supporting innovation will also need to focus on the influence that these policies have on innovation success. For example, the 'varieties-of-capitalism' (Hall & Soskice, 2001) approach shows that the institutional structures of different types of economies influence their innovation capabilities and innovation success. I did not include such conditions in my analysis, but they could yield interesting results.

There is also clear evidence that socio-economic factors are increasingly important for the positioning of innovation activities in global value chains. Looking at 'narrow' innovation policies (those that specifically target innovation activities) might not be sufficient as other framework conditions might be even more important. A thorough analysis of the factors influencing innovation success will have to include them as well into the research design and dataset.

CHAPTER 4: GOVERNMENT INTERVENTION IN SUPPORT OF OPEN INNOVATION: NATIONAL POLICY MIX FOR CREATING INNOVATION SUPPORTING ENVIRONMENT

As I have shown in the previous chapter, open innovation practices in SMEs that help them grow can be facilitated by special innovation policy measures that create and environment that supports their growth strategies. Government intervention has been shown to support growth strategies of SMEs. I have also demonstrated the new research methods that can help bring new insights into innovation policy making. However, open innovation can have another, even broader effect on the SMEs and other companies and their growth strategies. Global changes in organization of innovation, between countries and companies are influencing not only organization of innovation activities in the companies but also between them. SMEs have a special role in the changing environment as it allows them to both compete and cooperate with large companies that used to have a clear advantage for investing in innovation due to their size. In this chapter, I look at a broader picture of different mixes of national innovation policies and on many ways that different innovation policies can influence actors in the national innovation systems and influence their solving of the complex organisational problems involved in the transformation towards more open modes of innovating. Government intervention in innovation policies and other policies, social systems and institutions is analysed as the factors differentiating countries with successful national innovation systems.

The open innovation concept has already had a significant effect on innovation policy. Several studies have looked into implications of open innovation processes on policy-making. However, by acknowledging that structuring of innovation communities is of crucial importance to the implementation of open innovation practices, there is a considerable body of knowledge in the 'national systems of innovation' literature that can contribute to the development of open innovation theory. I could even compare different institutional structures between countries as researched in the 'varieties-of-capitalism' literature and examine their effects on implementing open innovation. However, there is a significant gap in the existing literature examining how different national innovation policies and institutional legacies will move towards the open model of innovation.

The number of publications on open innovation, while growing, is still rather limited. Most empirical studies have focussed on a small sample of cases, concentrated within high-tech-industries, and have addressed only a few countries, in particular the US. There is, therefore, a need to investigate countries departing from different legacies in terms of competition models, ways of coordinating the economy and welfare regimes (Chesbrough et al., 2006, p. 198). Enkel and Gassmann (2009) suggest that the shift to an open innovation paradigm must be brought about by simultaneous changes in industry structure, firm strategy, integration of suppliers, uses of intellectual property rights and by investing

in global knowledge creation. While I discuss these changes in more detail in Chapter Two, it is clear that these changes will be accompanied by new policy-making. But studies of these simultaneous changes and on the corresponding innovation policies are still rare.

This chapter intends to cover this gap in our knowledge. We've utilized a novel research method of quantitative comparison analysis (QCA) to analyse different configurations of innovation policies leading to successful innovation outcomes. Thus, I contributed to innovation policy research that is trying to incorporate the effects of the open innovation paradigm into a theoretically sound set of policies that will foster a successful transition towards open modes of innovating.

One of the reasons for the dramatically increased recent interest in open innovation is the potential that it may supply elements for a new growth regime that can cope with the financial crisis (Chesbrough & Garman, 2009; Finger & Stucki, 2009; Sousa, 2008) and the competition from BRIC-countries. By researching the innovation policies facilitating this transition, I also hope to provide policy-makers with new insights on how to best support it.

4.1 Theoretical background - Open innovation and its effects on innovation policy

4.1.1 Innovation research has been changed by the new innovation concepts, including open innovation

The open innovation concept (as well as other new innovation concepts) has made contributions to the innovation policy research that I have discussed in other chapters.

It's popularity has increased lately due to the onset of the economic crisis (Chesbrough & Garman, 2009) and the realization that innovation is also heavily influenced by globalization and the progress of the IT revolution (Wooldridge, 2010). One of the reasons for the dramatically increased interest in open innovation recently is the potential that it may help the innovation actors rebound after the recent crisis and even supply elements for a new growth regime (Chesbrough & Garman, 2009; Finger & Stucki, 2009).

However, what can policy-makers do to help facilitate the transition and improve the societal benefits that innovation can bring about? The open innovation paradigm emphasises the role of external inputs to its internal innovation process as well as external ways to the market for the results of its innovation. It strongly supports the development of innovation collaboration and cooperation, including market transactions in research, development and their commercialization. That is the rationale behind strong support for intellectual protection of R&D. However, the support for market transactions seems to

make the argument for policy intervention in the field of innovation contradictory. But new ways of conducting innovation do not mean that the markets for innovation function well. In fact, open innovation strongly supports government intervention in order to achieve better allocation of resources for innovation and to improve linkages between actors (Herstad & Bloch, 2008). As described elsewhere, open innovation adds the systemic failure argument for government intervention. Scholars argue that the standard market failure rationale for government intervention is not sufficient to promote the development and diffusion of new technologies as innovation is based on a complex evolutionary process that is distributed in a system of multiple socio-economic agents whose behaviour and interactions are governed not only by market forces but to a greater extent by non-market institutions (Bleda & del Río, 2013). Linkages between actors serve as channels for knowledge diffusion and recombination. Lack of linkages and networking across organizational boundaries represents a system failure, as do lock-ins to specific collaboration partners, sources of ideas and information or excessive overall 'closure' of learning processes (Herstad et al., 2010). These failures need to be tackled in a similar manner as with market failures – with policy intervention (Woolthuis et al., 2005).

Based on the market and system failure argument supporting innovation policies, it seems clear that open innovation needs elaborate innovation policies. Far from becoming redundant, they remain an essential element of industrial policies. However, the new way of thinking about openness and innovation does influence the changes in innovation policies (Herstad & Bloch, 2008; Herstad et al., 2010). Different policy measures are needed to facilitate open innovation activities than were needed to support innovation in the past. But different in what way?

4.1.2 Changes to innovation polices resulting from open innovation

The open innovation concept has already had a significant effect on innovation policy. Innovation policies are adjusting to changes connected to open innovation. Recently, several papers and studies discussed the question on how national innovation polices can be reframed in a context of open innovation (Ebersberger et al., 2011; Herstad et al., 2010 and others). They target different actors as the national policy measures than were used before for the spread of open innovation systems (Chesbrough, Vanhaverbeke, & West, 2011). They primarily target innovation policies in a 'narrow' sense, meaning that they target innovation activities directly. The results of these activities are specifically connected to innovation activities. One example of such a policy measure would be public support to various consortium research projects, since they aim to finance research as well as linkages between different institutions.

The most research on open innovation's effects on innovation policies was conducted by OECD. Their findings confirm the view that in the global supply of science and technology, large corporations are increasingly creating their own ecosystems (Moore,

1993) spreading across several countries. Global innovation networks have their own R&D capabilities as well as cooperation agreements with outside partners and suppliers. In these networks, companies are dependent on knowledge from partners (De Backer & López-, 2008). These global innovation networks incorporate individual researchers, research institutions (universities, government agencies…) and other companies across several countries.

These ecosystems and innovation networks are creating international hubs that connect regional and national innovation systems. The location of these innovation hubs is determined by the attraction of local innovation policies. Often, even competing ecosystems source their R&D and innovation in the same innovation hub in order to benefit from local polices and economies of scope and scale. As a result, boundaries of national innovation policies are increasingly blurred. New innovation policies need to be put into an international context from the beginning (Saxenian & Sable, 2008). The challenge of innovation policies in the open innovation framework is how to support domestic embedding of industrial knowledge development and innovation processes (Herstad et al., 2010).

This finding supports the concept of an innovation system that includes customers, suppliers, competitors, universities, government organisations etc. (Edquist, 2000; Lundvall, 1985; Nelson, 1993). They represent the general institutional and political framework for innovation ecosystems (Adner, 2006) where companies position themselves and their innovation activities.

However, if open innovation is influencing the regional location of innovation hubs, forcing different national innovation policies to compete among them to attract the evolution of such hubs in their territory, what kind of policies facilitate that? Are they dependent only on specific, narrowly focused innovation policies focused at spurring value creation and value appropriation aspects of the innovation activities? There are many examples of such policies aiming to increase public and private investments for R&D, protect intellectual property and other, narrowly defined policies that target increased innovation and their social returns. Are there other factors influencing the location of innovation activities in a modern, open and global innovation system? Besides traditional, ‘narrow’ innovation policies, other, ‘broad’ policies that do not target innovation activities directly but influence them unintentionally by making the innovation environment more attractive for positioning innovation activities could also influence the local embedding of industrial knowledge development and innovation processes.

One example could be that modern entrepreneurs are global and able to choose an environment where they start-up their new ventures. It makes sense for them to consider not only an innovation system where their venture will be established but also other factors that influence the overall quality of life for them and their employees. Other explanations

include agglomeration effects - entrepreneurs go where other entrepreneurs are also present – as well as other potential factors. Essentially, modern entrepreneurs are global and, similar to global capital flows, choose the most suitable environment for their positioning. And just like in global capital flows, global entrepreneurial flows do not depend solely on the specialised policies aimed at attracting them but are also dependent on 'broad' policies.

4.1.3 Varieties of capitalism and their effect on innovation in an open innovation framework

There is an important body of knowledge describing such 'broader' factors. By introducing other, broader aspects of economic policies that could influence the positioning of innovation activities, I can tap into the existing approach of varieties of capitalism (Hall & Soskice, 2001). This framework is useful for understanding the institutional similarities and differences among the developed economies that can be compared by reference to the way in which firms resolve the coordination problems. Institutional arrangements influence firms towards particular kinds of corporate strategies and thus influence innovation and their capacities. It also supports the systemic failure argument for innovation policy intervention as discussed above.

The 'varieties of capitalism' literature draws a distinction between a coordinated market economy and a liberal market economy. Different institutional and broad economic frameworks can have implications on the local positioning of innovation activities and facilitating the location of innovation hubs. The 'varieties of capitalism' theory of innovation explains the cross-national differences in innovation activity between industrialized democracies as a result of the variance in political institutions. The more a polity allows the market to structure its economic relationships, the more it will direct its inventive activity toward industries typified by 'radical' technological change. Conversely, the more a polity chooses to coordinate economic relationships via nonmarket mechanisms, the more it will direct its inventive activity toward 'incremental' technological change (Taylor, 2004).

Other studies have shown that institutional differences between market economies lead to variations in innovation strategies and patterns of innovative performance (for example Whitley, 2000). This argument is based on the institutional theory's premise that organizations are embedded within broader social structures, consisting of different types of institutions which exert a significant influence on the company's decision making (Ioannou & Serafeim, 2012). National level institutional heterogeneity can lead to comparative institutional advantage for those firms that operate within different countries (Jackson & Apostolakou, 2010). The national business systems approach is central to understanding the interaction between organizations, national contexts and international flows of capital, labour, technology and knowledge and international rule systems for coordinating these flows (Morgan, 2007).

As the ‘varieties-of-capitalism’ theory and ‘national business systems’ theory suggest, there is a limited amount of evidence that innovation is in fact not only dependent on ‘narrow’ innovation policies, but that other, ‘broader’ policies also influence innovation matters as well (Kristensen et al., 2011). Examples of such broader, structural policies include labour market, high-skilled labour force, capital markets, health and social security systems and others (e.g. (OECD, 2004). However, more empirical research is needed in order to confirm the notion that ‘broad’ policies influence the positioning of innovation activities in open innovation ecosystems.

4.1.4 Hypothesis development

Based on these questions I can set a formal hypothesis that I can test. I would like to see if I can explain the differences between the innovation successes of countries with only the differences between narrow innovation policies or do I also need to consider broader policies that influence innovation in order to explain those differences. More precisely:

Hypothesis 4.1*: Are narrow innovation policies necessary or sufficient for countries with innovation success?*

I can also test the opposite hypothesis:

Hypothesis 4.2: *Are broad innovation policies by themselves necessary or sufficient for countries with innovation success?*

While testing these two hypotheses, I can also find empirical confirmation of the original market failure and systemic failure arguments for government intervention in support of innovation. I can test the third hypothesis:

Hypothesis 4.3*: Are either ‘narrow’ or ‘broad’ innovation policies necessary or sufficient for countries with innovation success?*

4.1.5 Tools for testing the hypothesis

To test these hypotheses, I have developed a special tool called an innovation policy matrix. Different countries have different mixes of policies that influence innovation. As explained above, some policies are ‘broad’ since they do not target innovation activities specifically but rather influence them unintentionally. Their results are not focused on facilitating innovation activities but they nevertheless do so as they make the innovation environment more attractive for positioning innovation activities. Since they do not target innovation activities directly but only indirectly, I can describe them as remote conditions for innovation success. An example would be education policy that results in a well-

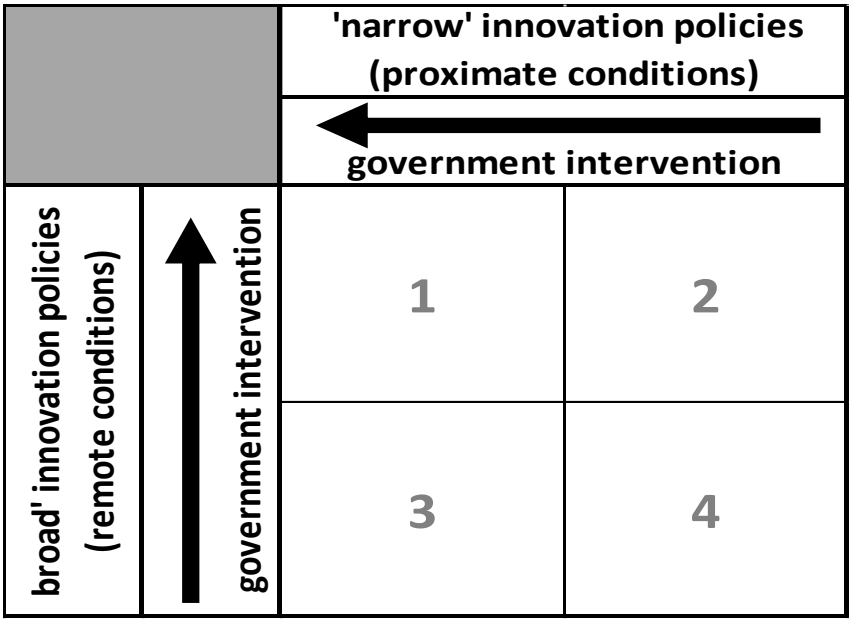
educated workforce with a sufficient number of workers with the knowledge and skills that innovation activities demand.

Other innovation policies do target innovation directly and are thus described as 'narrow'. The results of these activities are specifically connected to innovation activities. I can also describe them as being proximate conditions for the presence of the outcome – innovation success of a particular country. An example of such a policy measure would be public financing of basic research.

Remoteness and proximity can be interpreted in terms of space and time, but even more relevant for my research is their interpretation in regard to causal closeness. Remote factors are usually relatively stable over time as they cannot be as easily changed by actors as the proximate factors. They can even be regarded as exogenously given. Proximate factors vary over time and originate in the recent past. They can be relatively easily modified by actors (Schneider & Wagemann, 2012, p. 253).

We can show the expected results in the matrix.

Figure 8: Innovation policy matrix



In order to confirm the hypothesis, I expect to see results in the first cell. In that cell, both narrow and broad policies are present and support innovation success. The crucial test of my first hypothesis would be the cases in the cell number 3 where I have case of countries that are successful innovators and have specific 'narrow' innovation policies present, but do not have 'broad' policies that support innovation. If there are examples of countries present there, I would be able to reject the hypothesis that narrow innovation policies are

necessary but not sufficient for countries with successful innovation systems and that broad policies need to be present as well. Similarly, examples of countries present in cell number 2 would imply that only broad policies (but not narrow policies) are important for innovation success. They would allow us to reject my second hypothesis. Country cases in cell number 4 would mean that innovation success can be present without specific innovation policies, either narrow or broad. Such cases would actually reject the argument for the policy intervention in support of innovation. Both market and systemic failure arguments for innovation policy intervention would thus be rejected. They would allow us to reject my third hypothesis.

In cell number one, I expect to see countries that use both 'broad' and 'narrow' policies that support innovation. I expect to see several examples of such countries. However, these cases are actually irrelevant to my hypothesis testing as they only provide explicit expectations regarding the presence or absence of empirical cases in the three other cells of the matrix.

4.2 Methodology and data

As explained, my analysis of innovation policies is based on two distinct sets of policies. In order to operationalize the hypothesis, I've gathered a comprehensive dataset of indicators that measure broader policies and social systems – what OECD calls 'framework conditions'(OECD, 2004) – as well as indicators covering narrow innovation policies.
To measure narrow innovation policies I gathered data on indicators that measure crucial specialized innovation policies. Public support for basic research in universities and public research institutions, ease of knowledge transfers, intellectual property protection and sharing, construction of a broad knowledge base and support of 'innovation culture' is crucial to successfully implement open innovation policies (De Backer et al., 2008). This insight has been operationalized by OECD which has been gathering data on five principal policies designed to ease perceived constraints on the incentive for private firms to innovate (Jaumotte & Pain, 2005):

Broader innovation policy indicators are based on the theoretical foundation of the varieties of capitalism (VoC) framework that helps understand institutional similarities and differences between developed economies. The indicators that I chose roughly correspond to the five VoC spheres with which the firms must develop relationships with (Hall & Soskice, 2001): financial system and governance, internal structure of firms, industrial relations, education and training skills formation and inter-company relations

Additional measures such as an openness to invest and a tax regime were added due to their potential impact on the local positioning of innovation activities and innovative companies (Herstad et al., 2010, p. 115). In my final dataset, I therefore included indicators of broader innovation policies that cover the success of national health systems, retirement

systems, education systems, labour market, flexibility of tax regimes and openness for investments:

Table 18: Operationalization of broad and narrow innovation policy measures

Broad innovation policy innovators	
National health system	measured as the ranking of national health systems published by WHO
National retirement system	measured as the actual average retirement age
Labour market flexibility	measured by the rigidity of employment (OECD, 2004) index published by the World Bank in the Doing Business Report
Tax regime flexibility	measured as the time to pay taxes data published by the World Bank in the Doing Business Report
Openness for investments	measured as the combined share of foreign direct investments and outward investment's in the national GDP
Education system success	measured by the PISA Score published by the OECD
Narrow innovation policy indicators	
Direct public fiscal policies to stimulate innovation	measured as the government financed gross expenditure on R&D (GERD) as % of national GDP
Funding of public research organizations and measures to improve linkages between universities and industry	measured as the share of high-education R&D expenditure financed by industry
Intellectual Property	measured as triadic patent families per million population
availability of private finance for innovation expenditures	measured as industry financed GERD as a % of national GDP
availability of human resources for science and technology	measured as the share of total researchers (combined R&D personnel) in the total labour force

The most important and difficult measure was the one measuring innovation success. After a thorough investigation of innovation success measures such as total factor productivity, selected individual R&D indicators (of both R&D inputs such as share of R&D investments in GDP and R&D outputs such as granted patents), we've decided to use the output measures based on the data compiled in the Innovation Union Scoreboard. An integral part of the Innovation Union strategy of the European Union, it provides a comparative assessment of the research and innovation performance of the EU27 Member

states and the relative strengths and weaknesses of their research and innovation systems. As a benchmark, it provides comparisons with some other, large non-European countries. It helps member states to assess areas in which they need to concentrate their efforts in order to boost their innovation performance (Hollanders et al., 2013). The calculation of the annual composite IUS Summary Innovation Index allows the preparations of the country rankings and assures considerable publicity in the media and in the interested public. This is also likely one of the most important results of the IUS initiative that assures its continuation into its 14th year. While there is some considerable criticism of this approach (Pustovrh & Jaklič, 2014; Schibany & Streicher, 2008), the IUS Summary Innovation Index provides a relatively good foundation for aggregate innovation outcome for a relatively large number of countries. It will suffice for the aims of this analysis.

4.2.1 Fuzzy – set qualitative comparative analysis approach to innovation policy research

This chapter will use a relatively new approach of set-theoretic method to test the hypotheses. This method is uniquely appropriate for the task since it specifically allows testing for the causal complexity such as necessity and sufficiency of conditions leading to the outcome.

The qualitative comparative analysis (QCA) method was developed by C. Ragin (Ragin, 1987) and is based on the binary logic of Boolean algebra. The QCA examines how the membership of cases in the set of causal conditions is linked to membership in the outcome set (Allen & Aldred, 2011). As such, it is particularly useful when analysing country comparisons as their numbers are inherently small, but at the same time too high for the usage of other qualitative methods like case studies. Specifically, I will use the fuzzy – set qualitative comparative analysis (fsQCA) in order to analyse the causal complexity of innovation policies. By using this method I aim to obtain results that would correspond to the middle range theory based on empirical data. Neither purely qualitative nor quantitative, the QCA method also supports further research, especially in-depth case studies identified with the QCA method as being interesting to obtain more insight. I will emphasize them after obtaining the results of the QCA procedure.

4.2.2 Two-step qualitative comparative analysis approach

The analysis of broad and narrow innovation policies is a typical example of comparative social science research, where conditions can be divided into two groups that are labelled ‘remote’ and ‘proximate’ factors. This closeness is often defined with regard to causal closeness which they are assumed to have (Schneider & Wagemann, 2006). In my example, remote factors are often referred to as framework conditions and sometimes macroeconomic conditions and represent different national innovation systems (Nelson,

1993). Narrow conditions are identified as the factors that directly impact innovation activity in an individual country (Jaumotte & Pain, 2005). They are regarded as the usual tools for policy makers while framework conditions are often regarded as exogenously given. In my research, I have used broad innovation policy indicators as the remote factors and narrow innovation policy measure indicators as the proximate factors.

In the QCA procedure, I performed the QCA analysis of the 'remote' factors in the first step and proceed with the analysis of 'proximate' factors in the second step. The QCA approach is particularly well suited for the two-step approach since the number of logical remainders is drastically reduced (Schneider & Wagemann, 2006, p. 762). This reduction is the consequence of removing all potential combinations between remote conditions that have not shown themselves as being outcome-enabling. However, their removal has to be based on theoretical foundations, especially since it crucially depends on the division into remote and proximate conditions imposed by researchers (Schneider & Wagemann, 2012, p. 256). In my case, this division is clearly stated by the OECD based methodology, such as the OECD Oslo Manual (OECD, 2005). The two-step QCA approach represents a viable research strategy for comparative innovation policy research. Its benefit is clear as it allows the use the national policy data that are often hindered by their limited diversity due to the limited number of potential observations – countries with relevant data. Its potential benefit is enhanced since it allows researchers to analyse a larger number of conditions than in the standard single-step QCA approach.

4.3 Qualitative comparative analysis procedure and its results

4.3.1 Operationalization of the qualitative comparative analysis

To perform the fsQCA analysis, I have utilized the following steps:

a. I started by compiling the database of existing indicators on innovation policies in the EU.

b. These indicators were than calibrated and converted to (fuzzy) set membership scores.

c. We started my analysis with the analysis of the necessary conditions and followed with the analysis of sufficiency by implementing the truth table algorithm. This was done by following a two – step approach

   I) We first constructed the truth table for broad conditions (often called the outcome enabling solutions) – a data matrix where each row of the table is associated with a special and distinct combination of attributes and the full table consists of all possible combinations of attributes. I sorted all empirical cases into the rows of the truth table.

II) I performed the analysis of sufficiency by using the truth table algorithm – I minimized the truth table by reducing the number of rows based on the minimum number of cases required for the solution and the minimum consistency level of a solution. I followed the Standard Analysis procedure to minimize the truth table in order to obtain three solutions – complex, parsimonious and intermediate one. Based on the simplifying assumptions, I've used the parsimonious solution for interpreting the results of the outcome enabling conditions.

III) Finally, I constructed three additional truth tables in the second step of the two step QCA approach. We've constructed truth tables for each 'outcome-enabling condition' consisting of remote factors that were part of that solution in the first step and of all proximate factors. I logically minimized these tables using a much higher consistency threshold of 0.9 but used no assumption about the logical reminders. Thus, I obtained the final solution paths.

To execute the QCA procedure, I've used the fs/QCA software (Ragin et al., 2006 available at www.fsqca.com).

4.3.2 Dataset

We've compiled the data on eleven indicators and the outcome indicator in a new dataset. Raw data were gathered for a group of developed countries that were either members of the EU or the OECD in order to obtain relevant indicator data. I took 2010 as the benchmark year – in most cases this was the latest available data and even when data from later years were available they were often full of missing values. For outcome measurement of the IUS Summary Innovation Index, I've used data published in 2013 but in most cases based on 2010 data.

One important exception to the rule was health system data. WHO only published their health system ranking in 2000 and subsequent data was not available. I decided to use these data nevertheless as it provided the most comprehensible and reliable data on health systems in the world even though it was out-dated. The fact that changes to health systems are usually slow and not dramatic influenced this decision.

Even so, I also test the robustness of the dataset with an alternative measurement of health system success – life expectancy at birth. The results of the analysis were not significantly different. Similarly, I tested the robustness of the dataset by replacing another indicator – the tax regime flexibility – with a more general tax regime indicator of World Tax Index. The results were again virtually the same.

In the end, the final dataset had data on 11 indicators and the innovation outcome measure for 30 countries.

4.3.3 Data calibration

In the analysis, this data on individual conditions were transformed into set membership scores for the individual countries. I have used the fuzzy-set theory to obtain partial membership scores in each set for every condition and outcome (Ragin & Rihoux, 2009). Fuzzy sets are a superior way of measuring concepts due to conceptual validity but are also more demanding than crisp sets since they require a good knowledge of external standards in order to define the qualitative anchors for the calibration. Fuzzy membership scores fit well with my data since virtually all of my my indicators are based on a continuous scale. On the other hand, fuzzy-sets are a powerful tool that allows researchers to calibrate partial membership in sets without abandoning the core set theoretic principles (such as subset relations). They are at the same time qualitative and quantitative as they incorporate both kinds of distinctions in the calibration of the degree of set membership (Ragin & Rihoux, 2009). For most conditions, I have used a direct method of calibration. The direct method of calibration uses log odds (logit function) to obtain fuzzy membership scores. They have several advantages: they are perfectly symmetrical, cluster cases to the extremes and has neither a ceiling nor floor effect (Emmenegger, 2013). The condition describing education systems and the outcome were calibrated indirectly as I used existing calibration from the data source to obtain fuzzy membership scores. In my case, PISA test results were used as the measure of the quality of the education system in each country and I used their scores in order to define four distinct fuzzy membership scores. Similarly, I used the four groups of countries already defined by the Innovation Union Scoreboard's Summary Index and attributed fuzzy membership scores to each case based on their membership in these four groups.

4.3.4 Analysis of necessary conditions

After I have obtained a calibrated dataset I proceeded with the standard QCA analysis. I started my analysis with the test for potential necessary conditions that would lead to the outcome. There are no theoretical notions that would imply that any combination of conditions is necessary. Hence, I performed the test of necessity on all individual conditions as well as their negations. The results show that a single condition – good health system (noted as ~whohealth_calib)- has a consistency value of 0.95-signifiantly higher than at least 0.9 that is advisable (Ragin, 2006). While there was no theoretical rationalisation why that would be the case, the formal procedure indicated this condition as a candidate to be a necessary condition for the presence of innovation success. If the analysis of sufficiency would show its presence in all solution terms, I could conclude that good health system is necessary for successful national innovation system.

4.3.5 Analysis of sufficiency conditions – the truth table algorithm in a two-step approach

The XY plots of conditions and outcomes did not provide any definite suggestions about potential sufficient conditions. Therefore, I've proceeded with the two-step QCA approach. I first constructed the truth table only using the remote conditions and the outcome. The truth table was logically minimized, but a relatively low consistency threshold of 0.8 was used, leading to under-specified analysis. I obtained the first truth table presented in the table below.

This truth table yielded the solution term of 'outcome-enabling conditions' (Schneider & Wagemann, 2006, p. 761) of
(A*~B)+(C*D)+(~C*~D)→Y .

In the process of obtaining this solution, I used the parsimonious solution. Table 20 below presents the analysis of sufficient conditions and parameters of fit for the outcome – enabling conditions:

Table 19: Fuzzy-set truth table for the first step of two step qualitative comparative analysis analysis

A	B	C	D	E	F	Number of cases	Y	Raw consistency	PRI consistency
1	0	1	1	1	1	**1**	1	*0.96*	*0.93*
0	0	1	1	1	1	**3**	1	*0.95*	*0.91*
1	0	1	0	1	1	**1**	1	*0.93*	*0.87*
1	0	1	0	1	0	**1**	1	*0.93*	*0.86*
0	0	1	1	0	1	**1**	1	*0.93*	*0.90*
1	0	1	1	0	0	**2**	1	*0.92*	*0.87*
1	0	0	1	1	0	**1**	1	*0.92*	*0.79*
0	0	0	0	1	1	**1**	1	*0.90*	*0.72*
1	0	0	0	0	0	**2**	1	*0.90*	*0.78*
0	0	0	0	0	1	**1**	1	*0.90*	*0.70*
0	0	1	1	0	0	**2**	1	*0.87*	*0.77*
0	0	0	0	0	0	**2**	1	*0.87*	*0.63*
1	0	0	1	0	0	**1**	1	*0.80*	*0.57*
0	0	1	0	0	0	**2**	0	*0.74*	*0.52*
0	1	0	1	0	0	**1**	0	*0.71*	*0.37*
0	0	0	1	0	0	**5**	0	*0.66*	*0.36*
1	1	0	1	0	0	**1**	0	*0.64*	*0.32*

Notes: ***Relatively low consistency threshold of 0.8 was used in accordance with the methodology requirement of under-specification analysis in the first step of the two step QCA procedure. No logical reminders were used in the logical minimization procedure* (C. Q. Schneider & Wagemann, 2012, p. 254).

***** *A= educ_calib = Education system condition measured by PISA rating*
B= Health_calib = Health system condition measured by life expectancy at birth
C= pension_calib = Pension system condition measured by the average retirement age
D= labour_calib = Labour market condition measured by the rigidity of employing workers index (part of Doing Business Report, compiled by the World Bank)
E= tax_calib = Flexibility of the tax system condition measured by the time to pay taxes (part of Doing Business Report, compiled by the World Bank)
F= open_calib = Openness for investments measured as the sum of FDI and outward investments
Y (outcome)=IUSSI= Innovation Union Scoreboard Summary index score

Table 20: Analysis of sufficient conditions for the outcome-enabling conditions

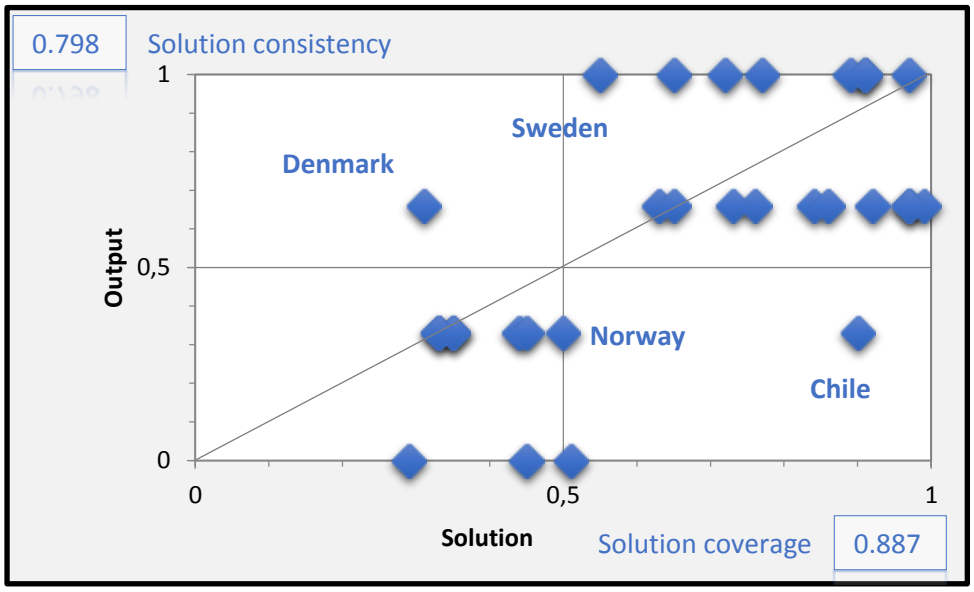
Solution	*A*~B* +	*C*D* +	*~C*~D*
Single country coverage	NL, EE, BE, PL	USA, ISR, CHL, IE, UK, DK, SE	LU, FR, SI, DE
Consistency	0.89	0.86	0.74
Raw coverage	0.69	0.49	0.34
Unique coverage	0.15	0.14	0.06
Solution consistency		0.80	
Solution coverage		0.89	

Notes: * *Obtained with the frequency cut-off = 1 and consistency cut-off = 0.80 where*
A= educ_calib = Education system condition measured by PISA rating
B= Health_calib = Health system condition measured by life expectancy at birth
C= pension_calib = Pension system condition measured by the average retirement age
D= labour_calib = Labour market condition measured by the rigidity of employing workers index (part of Doing Business Report, compiled by the World Bank)
*** Finland and Taiwan are members of two solution paths (A*~B) in (~C*~D)*
**** Japan, Korea and Switzerland are members of different two solution paths (A*~B) in (C*D)*

The first thing that I can observe is that none of the conditions is present in all solution terms. This means that none of the conditions is a necessary condition for the presence of the outcome – a result contradicting the initial suggestion from the formal analysis of necessity. This means that none of the broad conditions is by itself necessary for the presence of the outcome. Following the first step of my analysis, a good health system is not necessary for successful national innovation system even though the formal analysis of necessity suggested that this could be the case.

However, the quality of these findings is not perfect as both consistency and coverage of solution are less than perfect (their score is lower than 1). The plot of the solution (in Figure 9) shows that there are a number of typical cases that lay very close to the bisecting line and several irrelevant cases with a very low solution outcome. However, the plot also shows several deviant cases that the solution does not explain well. For example, the cases of Chile and Norway are decreasing consistency score of the solution – their high solution score does not correspond to a high output score. They are deviant cases for consistency in degree. This could imply that some conditions could be missing in the sufficiency path to explain them. Similarly, there are cases (for example Denmark and Sweden) that are decreasing the coverage of the solution as they have a relatively low solution score but have very high output scores. Their presence could imply that entire solution path could be missing in the solution. These cases (countries and their innovation policies) are good targets for more research and special case studies.

Figure 9: XY plot for the outcome-enabling solution



Notes: * Solution consistency and solution coverage are reported in the corners

It is clear that existing broad conditions do not explain the whole story of the innovation policies leading to success. These drawbacks of the output – enabling solution are actually inherent in the two-step QCA analysis since the first step is intentionally under-specified in order to allow for a more in-depth analysis of the second step of the QCA procedure.
In the second step, I've constructed truth tables for each 'outcome-enabling condition' consisting of remote factors that were part of that solution in the first step and of all proximate factors (Schneider & Wagemann, 2012, p. 254). Following this procedure, I constructed three additional truth tables.

The task in the second analytical step was to find different combinations of institutional and policy-making features within the three different contexts that lead to the outcome. The logical minimization of these tables, where I used a much higher consistency threshold of 0.9, yielded several sufficient paths towards the outcome. In the second step, I used no assumption about the logical reminders.

Using this procedure I acquired 25 different paths combining remote conditions (outcome-enabling contexts) and proximate conditions. They are presented in the table below.

Table 21: Analysis of solution paths leading to the presence of the outcome

Solution path	educ	health	pension	labour	open	tax	GovRD	U-I links	IPR	IndRD	HR RD	Consistency	N
1	A*	B*					~G	H	I	J		0.98	2
2	~A*	~B*					G	H	I	J		0.99	5
3	A*	B*					G	H	I		K	0.98	3
4	~A*	~B*					G	H		J	K	0.99	3
5	A*	B*					G	H		J	K	0.99	3
6	~A*	~B*					G		I	J	K	0.99	4
7	A*	B*					G		I	J	K	0.99	3
8	A*	B*					G	~H	~I	~J	~K	0.94	1
9	~A*	~B*					~G	H	I	~J	~K	0.98	1
10				D			G	H		J	K	0.98	4
11			~C				G	H	I	J		0.99	5
12				~D			G		I	J	K	0.99	5
13			C	~D			~G	H	I	J		0.98	2
14			C	~D			G	H	I		K	0.97	2
15			C	~D			G	~H	~I	~J	~K	0.93	1
16			~C	D			~G	H	I	~J	~K	0.97	1
17			C	D			~G	H	I		~K	0.98	2
18			~C	~D			G	H	I	J		0.98	3
19			~C	~D			G	H		J	K	0.98	4
20			~C	D				H	I	J	K	0.98	2
21			C	D			G		I	J	K	0.99	4
22			C	D			~G	~H	~I	~J	~K	0.93	1
23			~C	~D			~G	H	I	~J	~K	0.97	1
24			C	~D			G	H	I	~J	K	0.94	1
25			C	D			G	H	I	J		0.99	3

Notes: * *A= educ_calib = Education system condition measured by PISA rating*
B= Health_calib = Health system condition measured by life expectancy at birth
C= pension_calib = Pension system condition measured by the average retirement age
D= labour_calib = Labour market condition measured by the rigidity of employing workers index (part of Doing Business Report, compiled by the World Bank)
E= tax_calib = Flexibility of the tax system condition measured by the time to pay taxes (part of Doing Business Report, compiled by the World Bank)
F= open_calib = Openness for investments measured as the sum of FDI and outward investments
G=gerd= Government financed gross expenditure on R&D (GERD) as % of national GDP
H=industryherd= share of high-education R&D expenditure financed by industry
I=triadic= triadic patent families per million population
J=industrygerd= industry financed GERD as % of national GDP
K=personell= the share of total researchers (combined R&D personnel) in the total labour force
~=negation of each condition (lack of success in particular condition)
Y (outcome)=IUSSI= Innovation Union Scoreboard Summary index score

4.4 Results

Based on the final solution paths obtained after the second step of the two-step QCA procedure, I can finally reject the initial observation from the analysis of necessity. A high consistency score in the initial analysis of necessity implied that a good health system could be a necessary condition for a successful national innovation system. The table above clearly shows a number of solution terms that do not include a good health system. I can conclude that a good health system is not necessary for a successful national innovation system. There is also no other single condition, neither remote nor proximate,

that would be present in all solution terms. This means that no single condition is necessary for innovation success.

However, there are a number of sufficient conditions for it. The table of solution terms above is clearly very complex and an immediately clear answer to my hypotheses is not visible. All solution paths in the table have very high consistency scores and are represented by at least one country that has actually had this configuration of remote and proximate factors to obtain the outcome. This means that all of these paths lead to innovation success (all 25 combinations of narrow and broad conditions in solution paths led to innovation success). I also observe that none of the paths is comprised solely of remote conditions nor from proximate conditions. All of the paths are combinations of both. All 25 solutions include sufficient conditions among proximate as well as remote conditions.

However, to confirm my hypothesis, I need to check the remote conditions individually. Some of these conditions are actually implying a lack of success in certain areas that could be either due to a lack of specific policies, the lack of their success or because the results are not connected to policies at all.

In order to do so, I will present the solution terms in an innovation policy matrix that I specified in the beginning. I start by organizing the solution paths in a result matrix that helps us to group solution paths based on the amount of government intervention that they require.

Table 22: The result matrix: Analysis of solution paths in regard to the level of government intervention

						proximate conditions										
						Focus on most narrow innovation policies					mix of focused innovation policies and lack or ambiguous narrow innovation policies in other areas					no narrow innovation policies
						government intervention										
						most policies, no personell	most policies, no industryGERD	most policies, not triadic patents	most policies, no industryherd	most policies, no govGERD	Focus on public R&D invest.	Focus on public research alone	Focus on private research	Good collaboration between public and private but low invest.	private investments but low personell	neoliberal
						GHIJ	GHIK	GHJK	GIJK	HIJK	GHI~JK	G~H~I~J~K	~GHIJ	~GHI~J~K	~GHI~K	~G~H~I~J~K
remote conditions	government intervention	governmetn intervention in one or more broad policy areas (coordinated market economies)	early retirement and rigid labour market	~C	~D	p18		p19						p23		
			early retirement	~C		p11										
			rigid labour market		~D				p12							
		mixed systems	late retirement but rigid labour market	C	~D		p14				p24	p15	p13			
			early retirement but flexible labour market	~C	D					p20				p16		
			bad education system, good health system	~A*	~B*	p2		p4	p6					p9		
			good education system, bad health system	A*	B*		p3	p5	p7			p8	p1			
		liberal market economies	flexible labour market		D			p10								
			late retirement, flexible labour market	C	D				p21		p25				p17	p22

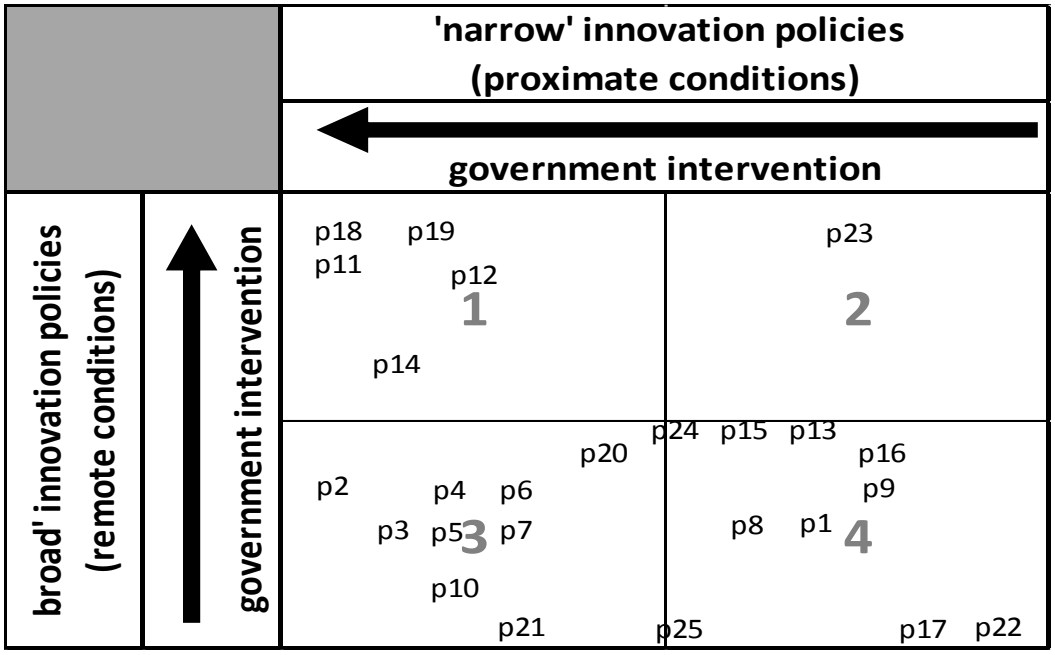
We can see that one solution path – p22, represented by Ireland – will lead to innovation success even in a situation with no apparent (successful) government intervention. Another solution path – p17, represented by UK and Japan – has only minimal government intervention in the way of focusing on two specific narrow innovation policies. At least the p22 solution path can definitely be qualified into the fourth cell in my innovation policy matrix as defined in the beginning. This solution path allows us to reject the third hypothesis – that countries with more and better public policies – either broad or narrow – will have more successful innovation systems. Even though the results are limited to a single solution path, this is sufficient to state that countries can have good innovation systems without successful government intervention.

Even so, the result matrix also shows that there are more solution paths leading to innovation success with government intervention. There are 23 solution paths leading to innovation success with at least some government intervention.

From the result matrix I can make several more observations. There are four solution paths that have high government intervention in both narrow and broad policy measures and can be classified into the first cell in my result matrix. Another solution path – p23, represented by Luxembourg – has relatively unsuccessful narrow policies but has a high level of government intervention in broad policies. It can be classified into the second cell of the matrix. There are at least two solution paths – p10 (represented by Slovenia, Denmark, Taiwan and Finland) and p21 (Israel, South Korea, USA and Switzerland) – that have low government intervention in broad policies but high intervention in narrow policies. They can be classified into the third cell of the result matrix. There are also a number of solution paths that are mixed and between different cells in the result matrix.

The existence of solution paths that lead to innovation success either without successful government intervention on the narrow or broad factors allows us to reject the original hypothesis that narrow innovation policies are necessary but not sufficient for countries with successful innovation systems. I have seen before that no single policy has been proven necessary for innovation success. I can now also see that the existence of solution paths (leading to successful innovation outcomes) in countries without a strong government role in narrowly focused innovation policies (in cell number two in the result matrix) allows us to reject the second hypothesis that narrow policies are sufficient for innovation success.

Figure 10: Result matrix for all solution paths



Based on this analysis, I can reject all three hypotheses that were tested. Neither narrow nor broad innovation policies are necessary or sufficient for countries with innovation success.

4.5 Implications

4.5.1 Policy-making implications

From the result matrix it is clear that there are a number of different paths leading to innovation success. While we've rejected all three formal hypotheses, there are nevertheless some additional observations that can be made from the results that were obtained.

First, while narrow innovation policies are neither necessary nor sufficient, government intervention is more often associated with innovation success. In the result matrix, there are many more paths that include at least some of them than those that do not include them. Of the 25 solution paths, 16 show the presence of four (out of five) narrow conditions, two show the presence of three conditions, four show the presence of two conditions and two show the presence of a single condition. There is a single path (p22) represented by a single case (Ireland) that is counterfactual to the notion that narrow innovation policies lead to innovation success. While this means that I have to reject my hypothesis, these results also clearly show that countries striving to become successful innovators should develop specific innovation policies. They would face many different options while those that will not focus on developing narrow innovation policies will be left with the sole path

– trying to replicate Ireland's success. That might be risky since this solution path could be the result of other factors not tested in the analysis (such an example might be English-speaking workforce that has made it attractive to locating innovation activities of US multinationals, using it as a bridge to EU's markets). As I have emphasised in the limitations, Ireland's apparent innovation success without successful innovation policies is not necessarily the result of an intentional approach – Ireland has accepted an innovation strategy (Irish Innovation Taskforce, 2010) in the past and an apparent lack of innovation policies could simply be a lack of success from policies that were implemented. Of course, there are other solution paths also located in the third and fourth cell of the innovation policy matrix and there might be other cases not observed that could fit into the same solution path as Ireland. Therefore, the formal rejection of the hypothesis is still appropriate. These considerations only show that this solution path as well as the case of Ireland's innovation policies is an interesting case for further in-depth case study research. However, for policy-makers, it is a much safer bet to develop specific 'narrow' innovation policies if they seek innovation success.

The result matrix shows that it might make sense to focus narrow innovation policies on a few specific policies. There are no solution paths that show all well-developed innovation policies and most 'narrow' innovation policies leading to innovation success specialise in few specific policies. A total of 16 solution paths show specialisation in four narrow innovation policies, two solution paths specialize in three narrow polices, four solution paths specialize into two narrow polices and two solution paths only in a single narrow innovation policy. Among the solution paths that emphasize less than four narrow innovation policies (and also among 8 out of 16 solution paths with four successful narrow innovation policies), all but two solution paths include successful results in narrow innovation policies focusing on linkages between universities and industry (measured as the share of high-education R&D expenditure financed by industry) as well as strong protection of intellectual property rights (measured as triadic patent families). Other studies also show the special importance of linkages (for example Pustovrh & Jaklič, 2014) and they have a sound theoretical foundation in the open innovation paradigm. These two narrow innovation policies seem to be the most likely policies to support when specializing.

Specialisation in specific narrow innovation policies is certainly feasible when pursuing innovation success and could likely prove to save significant resources in emerging economies when trying to achieve innovation success.

A second set of implications from my results show that narrow innovation policies are important, but 'broad' policies and the structure of national business systems also matter. Initially, I can observe that both tax system flexibility and openness for investment (or lack thereof) were not conditions leading to innovation success. They were simply not relevant for innovation success. Other conditions are generally linked to the five VoC

spheres with which the firms must develop relationships with (Hall & Soskice, 2001). Of special importance are labour market flexibility and social systems in individual countries. This reinforces the 'varieties of capitalism' approach that countries can become successful innovators in either a coordinated or a liberal market economy. In reality, all varieties of capitalism have become mixed to a certain extent, but significant differences in coordination mechanisms remain. One of them are certainly incentives for entrepreneurs, often connected with the income inequality. A greater gap of incomes between successful and unsuccessful entrepreneurs (thus greater inequality) increases entrepreneurial effort and hence a country's contribution to the world technology frontier. In such cases, some countries will opt for a type of "cutthroat capitalism" that generates greater inequality and more innovation and will become the technology leaders, while others will free- ride on the cutthroat incentives of the leaders and choose a more "cuddly" form of capitalism (Acemoglu, Robinson, & Verdier, 2012). This could imply an advantage of liberal market economies for fostering faster innovation.

However, others oppose this view by emphasising that Nordic countries can be just as productive as the US and even more so in distinct sectors. They point to the fact that there is rather strong evidence against the claim that an American incentive system is necessary in order to be at the technology frontier (Maliranta, Määttänen, & Vihriälä, 2012). Nordic countries might be better in mobilising human resources as a larger share of the working age population is employed due to more inclusive educational, social and employment policies. My analysis confirms this view since it shows that there are possible solution paths to innovation success both within the more coordinated and the more liberal market economies. While paths in a more liberal market economy (with less government intervention in broad policies) are slightly more numerous, it is impossible to claim that innovation success is only their domain – successful innovative economies can also develop in the coordinated economy. The enabling welfare state of the Nordic countries is a potential conceptual reference for further research of such policies (Kristensen et al., 2009). However, even these systems can be improved and adjusted.

Finally, my results are based on existing data from the first decade of 2000's. However, the ongoing development of open innovation systems could lead to different results in the future. As open innovation ecosystems become more internationally organized and more competitive, the highly mobile creative class that is crucial for innovation success might put more emphasis on the characteristics of the environment that they will choose for work. They will choose the place for work or establish a company based on a number of characteristics connected to both narrow and broad innovation system indicators. While the results of my analysis do not show this happening yet, it could just be too early for such choices to be manifested.

4.5.2 Methodological implications

Finally, the results of my analysis show the causal complex nature of innovation policy and its effects on innovation success. The use of set theoretical methods is more reasonable and desirable since they can better deal with the causal complexity issues inherent in the policy-making research:

- Set relations are asymmetric since the solution formula is different for the presence of the outcome and the presence for the negation of the outcome. Due to space limitations, I did not explore the conditions leading to a lack of innovation success. However, even preliminary tests confirmed that solution paths leading to lack of innovation success would be different than those leading to innovation success and not merely negation of the paths leading to innovation success.
- They are equi-final as they consist of more than one sufficient condition. Different and mutually non-exclusive innovation policies can lead to innovation success. The United States has different innovation policies than Scandinavian countries and even more different than South Korea. However, they are all considered successful innovators.
- They show the characteristics of conjunctural causation. For example, there is clear evidence that single policies can unfold only in combination with other, precisely specified conditions. An example is investments into basic research that will only lead to innovation success if they are combined with successful applied research and commercialization policies. I can see several examples of conjunctural causation in my solution paths.

Statistical regression-based methods cannot achieve causally complex results as they cannot unravel set – relations and the form of causal complexity that comes with it. Unlike conventional statistical techniques which are based on examinations of sufficiency (Ragin, 2000), set theoretic methods can examine the links between various combinations of causal conditions and the outcome as both necessary and sufficient conditions. This is important, since it is yet to be established whether certain institutional features are either necessary and/or sufficient for countries to achieve desired innovation outputs. The use of set theoretic methods means that causal conditions that are necessary and that are sufficient can be explored. These findings may, in turn, lead to clearer policy implications than would be the case from an analysis of the marginal effects obtained from regression analyses (Fiss, 2011).

4.7 Limitations and suggestions for further research

Further research should follow from this analysis. It is recommended that following a QCA analysis, two groups of deviations should become the target of an in-depth case studies. In my example, I have recognized deviant cases for consistency in degree like Chile and Norway that could imply that some conditions could be missing in the sufficiency path to explain them. Similarly, there are cases (for example Denmark and Sweden) that are decreasing the coverage of the solution as they have a relatively low solution score but have very high output scores. Their presence could imply that the entire solution path could be missing in the solution. These cases (countries and their innovation policies) are good targets for more research and special case studies.

However, these cases were deviant only after the first step of the two step procedure and are therefore interesting mainly due to their deviancy in explaining outcome-enabling solutions. Following the second step of the approach, I have obtained as many as 25 solution paths with very high consistency scores. Deviations after the second step were less interesting due to the sheer number of different solution paths. It would make more sense to further analyse individual solution paths, especially those that are specifically important for the rejection or my hypothesis. For example, solution path number p22 (represented by Ireland) – that leads to innovation success even in a situation with no apparent (successful) government intervention – should be the target of further research. Another solution path – p17 (represented by UK and Japan) – is also interesting for the same reason. The best way to analyse them would be by implementing case studies on policy mixes (of both national innovation policies and broader policies/national business systems) of the countries that use them to reach innovation success.

There are several limitations in my research that also require further research. We've recognized the following:

- Methodological limitations: lack of temporal analysis and problems with using the results of the policies as measures for the policies themselves.
- Limitations connected to the quality of data: issues with missing data were dealt with, but more important was an issue of limited diversity that is basically unresolvable due to the limited number of potential case observations (industrially developed countries with innovation policies).

Methodologically, there are some limitations to this approach in analysing the innovation policies. First, the analysis is not temporal. Rather, its focus is set on the structural nature of innovation policies. Temporal analysis using the QCA method is possible but is not the aim of this chapter and was thus avoided. That is the reason why most of the indicators are focusing on a very similar timeframe (with the exception of health system data due to a

lack of reliable indicators after 2000). I see potential for temporal analysis of innovation policies in future research. A similar (although updated) dataset could be used and a variation of a QCA method is available for dealing with temporal effects.

Second, I am looking at the results of the policies and not the policies themselves. Indicators only show the success or failure of obtaining the results of individual policies. However, there could be cases where individual policies were present but simply failed to yield results. Alternatively, the indicators used as a proxy for the presence of the innovation polices could turn out to be the result of other factors. Unfortunately, I cannot test the intended results of individual policies. This limitation is important and should lead to further research on the effects of innovation policies and better measurement techniques to evaluate their success. For the countries of the European Union, there are additional data available on individual policy measures (both their presence, time span and inputs available for their implementation). This dataset holds great promise for further research if good outcome measures for individual policy measures could be defined.

While constructing my dataset, I had small but significant issues with missing values. For several indicators, data was not available for some countries. For that reason, I decided not to include several countries in the analysis – for example, India and Greece. In other countries, individual data points were missing. In most cases, I was able to find these data points for previous years (for example, for 2009 when 2010 data was missing), either in the same database as the original data (usually OECD and IUS) or from other secondary sources. Thus, I compiled data on 25 countries. For an additional five countries, I was able to obtain all data on indicators but were missing data on innovation outcome (the IUS Summary Index score). Three of those countries were the small economies of Israel, Chile and Taiwan and the other two were the global giants of Russia and China. Since I've used four-value fuzzy set values for innovation outcome (as will be explained below) and knew the methodology of calculating the IUS Summary index (Hollanders & Tarantola, 2011) I decided to estimate the outcome measures for these countries by ourselves. This estimation was much easier since I only had to determine which value out of the four-value fuzzy set to attribute to them. IUS Summary Index values for other countries (notably USA, Japan and Korea) were reported in the original IUS report but were calculated by using a slightly different methodology (Hollanders et al., 2013). I noted that the results might not be fully compatible with other countries but decided that they were reliable enough to attribute them with one of the four values for the fuzzy set.

Finally, when dealing with the national policy data, we are always hindered by their limited diversity due to the limited number of potential observations – countries with relevant data. There are only a handful of countries with innovation policy measures that we can use to analyse – the whole population of cases is very small. The use of statistical methods on such a small number of cases is of limited quality. However, one of the qualities of a QCA analysis is that we can use it on 'small-n' and that it tackles limited

diversity directly. It attempts to maximize the number of comparisons that can be made across the limited number of cases under investigation. The technique aims to resolve the problem of a small number of case observations by allowing inferences to be drawn from the maximum number of comparisons that can be made across the cases under analysis. Its potential benefit is enhanced with a two-step approach since it allows researchers to analyse a larger number of conditions than in the standard single-step QCA approach. The method used in this chapter is probably best suited for the research questions I have asked and for the (limited) dataset I was able to construct.

4.8 Discussion and theoretical contribution

The results of the analysis have lead us to a surprising conclusion – I rejected all hypotheses regarding the government intervention into support for innovation systems as I was able to show counter-examples of solution paths leading to innovation success without government intervention in either narrow innovation policies, broad policies or both. At the same time, I was able to show that many more solution paths show that government intervention is part of polices that lead to innovation success. How is that possible?

Actually, it is possible to reconcile both views to some extent. A formal logical requirement of necessity of specific policies for innovation success can be rejected if I can find a single case where innovation success is present without the presence of such policy. Clearly, I was able to find examples (solution paths with one or several observed cases in each of them) that allowed us to reject each one of my hypotheses. However, there were many more examples (solution paths) that were in line with my expectations. For practical reasons, policy-makers looking for innovation success would be well advised to seek policies that would maximize their chances of obtaining innovation success. That would surely be to embark on a specific national innovation policy with specific narrow polices (we also emphasized two specific policies most often present in different solution paths). This makes sense in both liberal market economies and in coordinated economies. The fact that innovation success is feasible without (successful) specific policies does not mean that this is the best bet for a developing economy.

GENERAL DISCUSSION AND CONCLUSIONS

Summary of the main findings

The broad research field was to research the intellectual structure of open innovation and to see if open innovation research has contributed to our understanding of innovation. Narrow research fields were looking at business application of open innovation practices in SME's and implications of open innovation on innovation policies. Additional contributions of this dissertation are the empirical study based on newly collected survey data on open innovation in high-tech SMEs and the implementation of new methodological tools that bring additional insights for (open) innovation policymaking. In the table below, I summarize the main findings and contributions of the dissertation.

Table 23: Summary of the main research questions, research methods, main findings and contributions in the first chapter

Chapter title	Research question	Research method	Main findings	Contributions
INTELLECTUAL STRUCTURE OF THE OPEN INNOVATION FIELD: STATE OF THE ART AND A CRITICAL LITERATURE REVIEW	1. What is the intellectual structure of open innovation and other innovation concepts? 2. Did open innovation contribute to fill the gaps in understanding innovation?	Literature review, biblio-metric methods	Open innovation is a distinct innovation concept that is here to stay. It does not act as a communication barrier - hindering growth in research and understanding, nor constrains future research. However, open innovation was not a true paradigm shift in innovation research.	This chapter shows that open innovation has made significant contributions to innovation research. However, it also shows that more contributions can be expected in several specific areas: - in the field of economic effects on open innovation, using empirical studies that remain scarce. - SME's remain under-researched - How to best organize environment and innovation communities to benefit from open innovation.

Table 24: Summary of the main research questions, research methods, main findings and contributions in the second chapter

Chapter title	Research question	Research method	Main findings	Contributions
ANTECEDENTS OF HIGH-TECH SMEs' COMMERCIALI-ZATION ENABLERS: OPENING THE BLACK BOX OF OPEN INNOVATION PRACTICES	3. What are the specific antecedents of high-tech SMEs' commercialization enablers? 4. How do two specific open innovation practices (open innovation information exchange and open innovation collaboration) impact high-tech SMEs' commercialization enablers through their innovation activities and innovativeness?	PLS SEM	We have constructed a working model of the antecedents of commercialization enablers of high-tech SMEs. It confirms that there is a strong and positive link between innovativeness and commercialization enablers in high-tech SMEs. The results also show that high-tech SMEs which engage in broader types of open collaboration display higher levels of innovativeness which also leads to a higher commercialization propensity. However, they show the absence of a significant relationship between open innovation information exchange and innovation activities.	This chapter contributes to the open innovation research by conducting more focused research related to open innovation within high-tech SMEs. I was able to fill an even greater empirical void on this topic related to high-tech SMEs from transition and post-transition economies in Eastern Europe. The results also show that open innovation collaboration – as a specific open innovation practice – is a significant antecedent to commercialization enablers of high-tech SMEs which are in the case of my data strongly determined by high-tech SMEs innovativeness. An important contribution is an insight that commercialization is not just directly connected to open innovation, but outlines a clear mechanism of action (impact through innovativeness).

Table 25: Summary of the main research questions, research methods, main findings and contributions in the third chapter

Chapter title	Research question	Research method	Main findings	Contributions
NATIONAL INNOVATION POLICIES IN THE EUROPEAN UNION: A FUZZY-SET ANALYSIS	5. Can new methodological tools bring new insights into innovation policy research? 6. Do linkages among actors and innovation commercialisation through entrepreneurship represent a necessary condition for innovation success?	fsQCA	The results of my QCA analysis showed causally complex characteristics of innovation policies that the QCA method can unravel but standard statistical methods cannot. The demonstration of the fsQCA procedure on my dataset also confirmed the special importance of *Linkages & entrepreneurship* as a necessary condition for innovation success, confirming that the open innovation premise innovation depends on the extent of mutual cooperation. Its absence represents a systemic failure and should be tackled through policy intervention.	The contribution of this chapter is to demonstrate new methods for the analysis of innovation policies that can lead to new or different policy recommendations. We were able to show the special importance of linkages among actors and innovation commercialisation through entrepreneurship, confirming that they represent a necessary condition for innovation success. The importance of an open innovation framework for innovation policy-making was thus emphasised.

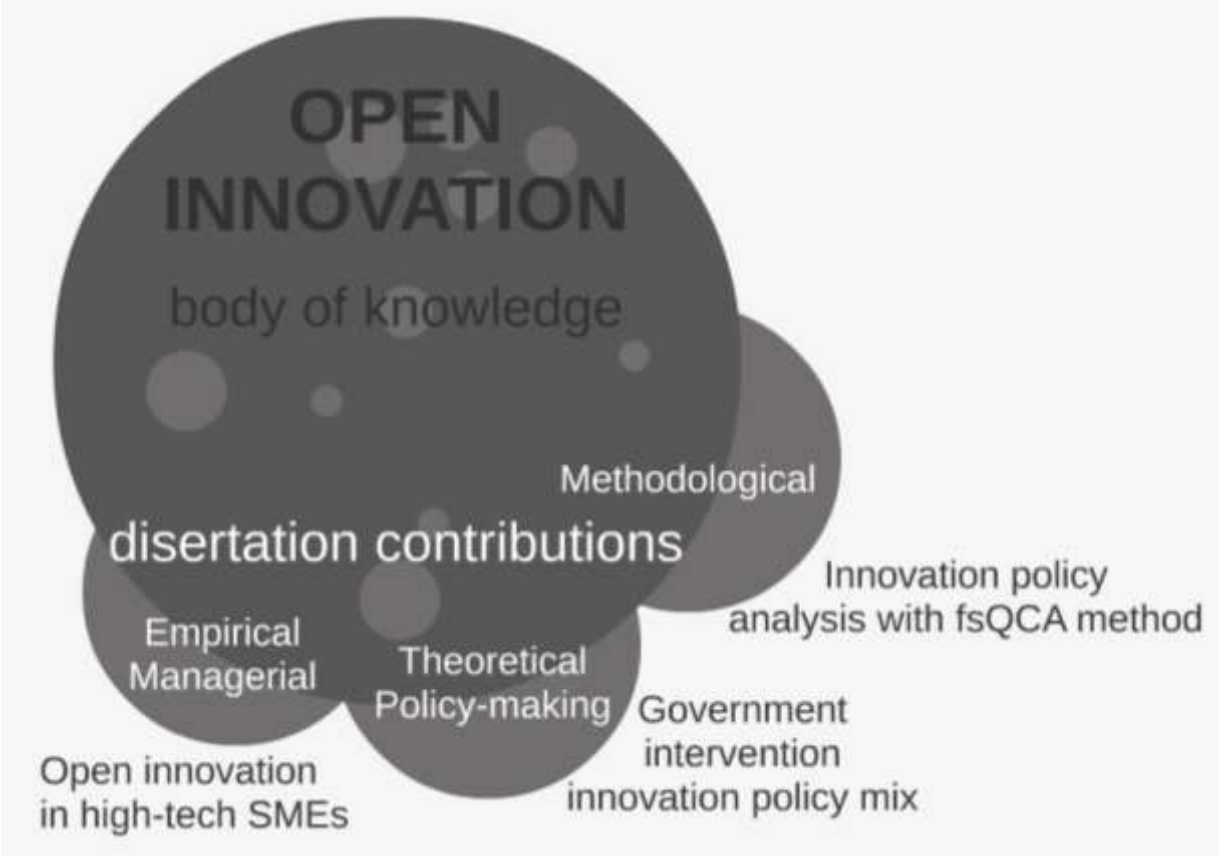
Table 26: Summary of the main research questions, research methods, main findings and contributions in the fourth chapter

Chapter title	Research question	Research method	Main findings	Contributions
GOVERNMENT INTERVENTION IN SUPPORT OF OPEN INNOVATION: NATIONAL POLICY MIX BEST SUITED FOR INNOVATION SUCCESS	7. How can different innovation policies influence actors in the national innovation systems and influence their solving of the complex organisational problems involved in transforming towards more open modes of innovating 8. Is there a difference between traditional, 'narrow' innovation policies, and other, 'broad' policies that could also influence the local embedding of industrial knowledge development and innovation processes?	Two – step fsQCA	Neither narrow nor broad innovation policies are necessary or sufficient for countries with innovation success. However, there are a number of different paths leading to innovation success. Formally, innovation success can be obtained without successful government intervention. But there are many solution paths leading to innovation success with government intervention. Countries striving to become successful innovators should develop specific innovation policies. To policy-makers, it might make sense to focus narrow innovation policies on few specific policies and not try to succeed by developing all policy measures.	The results of the analysis contribute to the questions regarding the extent and nature of government intervention to support innovation activities. We showed that, formally, government intervention is not necessary for innovation success, but at the same time, I was able to show that many more solution paths show that government intervention is part of polices that lead to innovation success. That means that while government intervention is not formally necessary, it is still the best option when pursuing innovation success. Finally, I contributed to the (open) innovation policy research by introducing a new methodological tool for analysing proximate and remote conditions influencing innovation success – a two-step QCA method.

Summary of main contributions

This dissertation adds several theoretical, methodological and empirical contributions to the field of open innovation.

Figure 11: Overview of dissertation's contributions



Theoretical contributions

In Chapter 1, I have shown that open innovation has made significant contributions to innovation research. However, the same chapter also shows that more contributions can be expected in several specific areas, among others:

- in the field of economic effects on open innovation, using empirical studies that remain scarce;
- Small and medium sized companies especially remain under-researched.

My contribution to open innovation research was the comprehensive analysis of crucial research areas and open questions in innovation research and the comparison to which of those questions open innovation has contributed to.

For example, a theoretical contribution is the insight that open innovation has focused very much on how innovation activities are organized in companies, but much less on how to best organize environment and innovation communities to benefit from open innovation. The societal organization challenges are discussed in both Chapter 1 and Chapter 4, but much more research will be needed in the future. I tried to map this specific innovation area in need of more research.

In Chapter 2, I was able to contribute to the open innovation research by conducting an empirical survey on open innovation within high-tech SMEs. A clear contribution to science is also the construction of a working model of the antecedents of commercialization enablers of high-tech SMEs. It clearly shows that open innovation collaboration – as a specific open innovation practice – is a significant antecedent to commercialization enablers of high-tech SMEs (which are in the case of my data strongly determined by high-tech SMEs innovativeness). Another important contribution is an insight that commercialization is not just directly connected to open innovation, but outlines a clear mechanism of action (impact through innovativeness).

In Chapter 3, I was able to show the special importance of linkages among actors and innovation commercialisation through entrepreneurship, confirming that they represent a necessary condition for innovation success. Continuing the theoretical contribution to innovation policy research in Chapter 4, I've shown that government intervention is not formally necessary for innovation success. However, at the same time, I was able to show that many more solution paths show that government intervention is a part of polices that lead to innovation success. That means that while government intervention is formally not necessary, it is still the best option when pursuing innovation success. Even when the government's role is not clearly focused on narrow innovation policies (or they remain unsuccessful), the government still has a broader influence on the environment that supports innovation. Of course, innovation (eco) systems are diverse and the role of the government varies in different innovation (eco) systems, spanning from broad policies that also influence innovation to the institutional structure of the economy. Analysis on the necessary and sufficient conditions (innovation policy measures) for innovation success yielded more insights into the innovation policy research.

Methodological contributions

In this dissertation, a special emphasis was placed on using novel research methods on open innovation topics, in order to obtain more insights. I have used this approach in every chapter of my dissertation.

In Chapter 1, I've combined the existing approach to analysing contributions to the body of knowledge on innovation and applying this framework to the analysis of contributions of open innovation.

In Chapter 2, I've employed Structural Equation Modelling (SEM) to test my conceptual model. Within SEM, I've decided to employ a variance-based Partial Least Squares (PLS) modelling approach rather than the traditional covariance-based Ordinary Least Squares (OLS) modelling approach. Several factors influenced my choice of PLS SEM: our survey-based variables were not distributed normally; my model testing is exploratory in nature; my sample size is limited; the model is fairly complex (given the sample size); there is potential item multi-colinearity; and my focus is to estimate the predictive power of my model. In all these cases, PLS SEM has been recommended over more usual OLS SEM.

However, the most important methodological contribution was the demonstration of new methods for the analysis of innovation policies that might lead to different policy recommendations. I've used a set-theoretic method called qualitative comparative analysis (QCA), more precisely its fuzzy set variant fsQCA. The main aim of Chapter 3 was to demonstrate new methods for the analysis of innovation policies as they have the characteristics of causal complexity. For such phenomena, standard correlational statistical methods are not appropriate, but remain widely used. The demonstration of the use of fs QCA in this chapter to analyse the causal complexity of innovation policies, shows that this method can provide important new insights and should be used more often by scholars studying innovation.

In Chapter 4, I've upgraded the fsQCA method and used its two-step variant to analyse a large set of 'narrow' and 'broad' innovation policies. This method is uniquely well suited tool for analysing proximate and remote conditions influencing innovation success and has never been used before in innovation policy research.

Managerial contributions

In Chapter 2, the construction of a working model of the antecedents of commercialization enablers of high-tech SMEs has clear implications for managers of such companies. It confirms that there is a strong and positive link between innovativeness and commercialization enablers in high-tech SMEs. The results also show that high-tech SMEs which engage in broader types of open collaboration display higher levels of innovativeness which also leads to a higher commercialization propensity. The lesson for them is clear: managers of high – tech SMEs can see their companies benefit from applying open innovation activities. In Chapter 1, I provide further insights regarding the connection of open innovation research and the 'lean' approach to implementing and commercializing innovation. Its shows that open innovation systems are theoretically closely related to the 'lean' approach, especially by their contributions in the field of open business models. The 'lean' approach can be extended from the usual 'lean start-up'(Blank, 2013; Ries, 2011) methodology also to 'lean' entrepreneurship approach in large companies (Owens & O., 2014) and even to the 'lean policy-making' approach I

discuss in Chapter 3. It describes novel forms of organization and networks between companies and their partners. It wholly endorses the new 'combinatorial innovation' (T. Economist, 2014) describing the technological and start-up explosion as a system integration of newly emerging (digital) platforms.

In addition, the results obtained in my analysis in Chapter 2 support two well-established managerial theories. First, related to the theory of the firm, my results show a much higher impact of internal factors on innovation activities of high-tech SMEs vis-a-vis the impact of external factors on high-tech SMEs' innovativeness. This is consistent with the resource-based view of the firm and the pecking order theory of the firm where SMEs seem to be first-and-foremost limited by a lack of internal resources (Mörec & Rašković, 2011), only then constrained also by external and institutional factors (Radas & Božić, 2009).

Policy making contributions for supporting successful and growing small and middle sized enterprises

Both Chapters 3 and 4 yielded important policy making contributions. In Chapter 3, I was able to show the special importance of linkages among actors and innovation commercialisation through entrepreneurship, confirming that they represent a necessary condition for innovation success. This makes innovation polices supporting linkages and entrepreneurship uniquely important. Based on the systemic failure argument discussed in Chapters 1 and 3, it also gives policy makers a rationale for implementing policy measures aiming to target them (and other measures). Continuing innovation policy research in Chapter 4, I've shown that while it is justified due to the systemic failure argument, government intervention is not necessary for innovation success. However, at the same time, I was able to demonstrate that many more solution paths show that government intervention is part of polices that lead to innovation success. That means that while government intervention is not necessary, it still makes sense. I provide further insights in Chapter 4 on what kind of policies should be implemented and how to implement them.

Summary of the limitations and future research opportunities

There are several limitations of this dissertation that represent future research opportunities. The **first set of limitations is connected to the research of open innovation in SMEs.** Our survey, which was the source of data for the analysis in Chapter 2, was limited to Slovenia. As a consequence, the sample size was fairly limited. This also influenced the characteristics of the sample. One area of future research will be additional work on open innovation in SME's, potentially expanding the survey internationally with the aim of exploring differences between SME's usage of open innovation activities in different national business systems. Future research would have to be based on a survey

covering a wider geographical area (several countries) that would yield a large sample. This would also allow us to remove some companies from the dataset.

The small dataset has also influenced the second set of my research limitations. They may be seen in testing only two specific open innovation practices. Despite including two of the most fundamental open innovation practices, which I believe to be crucial to SMEs in particular, namely information exchange and external collaboration, other practices and activities should also be considered in the future. For example, more research should be conducted on researching the effects of other open innovation activities like licensing, spin-offs and joint-ventures, as well as buying IP in terms of high-tech SMEs' commercialization activities. While these activities were actually included in the original questionnaire that we've used, too few companies provided answers and they could not be tested in my model. A larger sample size would help test these open innovation practices as well.

The third set of my research limitations is connected to the way I have operationalized specific constructs in my model. In this regard, I have to once again point out that I have taken a very broad and self-reported approach to measuring the commercialization activities of our high-tech SMEs. However, I believe that such an approach is more appropriate for SMEs as it more realistically measures their commercialization "mind set" and propensity. Using more elaborative and quantitative criteria for the commercialization of innovation did not work when applied to Slovenian high-tech SMEs in the past.

In addition, we cannot directly draw causal conclusions from our SMEs' data because the data gathered are cross-sectional. A great opportunity for future work would be to follow the companies that were in my original sample for several years and add temporal data about their open innovation activities as well as their results. Compared with another, non-open innovation-using group of companies, such a dataset would allow us to test if open innovation improves the financial results of the companies in due time. Finally, my data was gathered using a single respondent approach, which was deemed as better than using a number of less informed respondents. Besides these opportunities for future research, an interesting way to further analyse the effects of open innovation on SMEs would be action research.

Of special interest are the most successful companies that have successfully used their innovation activities to join global value chains (or even establish their own). Small multinational companies and even small global companies were made possible by the new globalization of innovation and the emerging start-up ecosystems (Economist, 2014; Kristensen & Zeitlin, 2004). They should be studied carefully by conducting several in-depth case studies or should be targets for action research.

These companies also employ a new kind of workforce. The new entrepreneurs (often called 'founder's) and specialised technical workforce are increasingly global and sometimes referred to as the 'new argonauts' (Saxenian, 2007). More empirical research would be welcomed, as they seem to be one of the most important factors behind global knowledge creation and diffusion.

The **second set of limitations is connected to innovation policy research** and the use of new research methods.

My analysis of national innovation policies in Chapters 4 and 5 could benefit from expanding the dataset to include other countries. The issues of limited diversity are always present when working with national data since their number is limited. When working with countries that implement innovation policy measures, the limit is much lower as most of the less-developed countries do not utilize such policies. Nevertheless, my dataset could be expanded to some additional countries. Similarly, there are significant methodological issues with using existing data (that I've highlighted in Chapter 3), so the dataset could be expanded with other or just more indicators. The calibration of the dataset can also be further improved.

There is another methodological limitation with the use of existing indicators on innovation. I've used these indicators as a proxy for measuring innovation policies. However, this is a simplification and in future research it would be much more desirable to develop a way to measure the success of innovation policies directly. Similarly, specific innovation policy measures could be analysed in more detail, using evaluation methods.

Both results in Chapters 4 and 5 (in the first step of the two-step fsQCA procedure) have yielded a number of countries that are not well explained by the solution paths. These countries are a good target for further research in the form of in-depth case studies.

As with the limitations of my research in open innovation in SMEs, the analysis of national innovation policies is not temporal. Methodological procedures exist that can analyse the temporal aspects (temporal QCA), but their use would exceed the aim of this dissertation. It would be interesting, however, to proceed with the temporal analysis in future research.

Recently, new advances in technology and globalization have spurred a unique 'start-up explosion', building on the foundation of national innovation systems (often described as ecosystems). They are not well researched but are becoming increasingly important for developing not only the competitive advantage of companies but also of countries (recognized at least since Schumpeter (1934). However, much research remains to be conducted on innovation policy that can spur growth and improve competitiveness.

Finally, one final limitation of the analysis of innovation policies in Chapter 3 and especially Chapter 4 is the fact that institutional characteristics of national business systems are not part of the analysis. Expansion of the research into the research of institutional structures and framework conditions for successful (open) innovation policy would be a very interesting path for further research.

Table 27: Potential directions for future research

Research of open innovation in SMEs
Trans-national research with the aim of exploring differences between SME's usage of open innovation activities in different national business systems.
Researching more effects of other open innovation activities like licensing, spin-offs and joint-ventures, as well as buying IP in terms of high-tech SMEs' commercialization activities.
Follow-up of the companies that were in my original sample for several years and add temporal data about their open innovation activities as well as their results.
Small multinational companies and small global companies were made possible by the new globalization of innovation and the emerging start-up ecosystems They could be studied carefully by conducting several in-depth case studies or be targets for action research.
Research connected to innovation policy research
Develop a way to measure the success of innovation polices and individual policy measures directly, not through proxy of existing indicators on innovation.
Specific innovation policy measures could be analysed in more detail, using evaluation methods.
Several countries were recognized as a good target for further research in the form of in-depth case studies.
Temporal analysis of policy intervention could be conducted.
More research could be done on innovation policies that support the 'start-up explosion .
Expansion of the research into the institutional structures and framework conditions for successful (open) innovation policy.

Concluding remarks

In Chapter 3 and especially in Chapter 4, I have focused primarily on the role of government intervention in the form of broad and narrow innovation policies, innovation policies that support open innovation will likely also have to develop new institutions or at least change the content of the existing institutions. Innovative changes to institutions, social systems and broad policies that also influence innovation will lead to a different institutional structure of capitalism than what we are familiar with today. The fast pace of changes in innovation activities, positioning and policy-making will demand more flexible institutions and faster changes of policy-making –a sort of a lean policymaking approach. While this is not the target of this dissertation (and will surely be a target of much future research), I can speculate on some trends in policymaking already apparent today.

Advances in digital technology have spurred an entrepreneurial explosion that is reshaping entire industries and even changing the very notion of the firm (Economist, 2014). It will bring radical changes, including those for workers where the needs of the companies of tomorrow will be much different. Many people may find it hard to get used to them as they do not have the appropriate skills and knowledge for the digitalized world of the future. Government will have a role in supporting them, both in protecting them and helping them be more employable. Education systems and flexible market solutions supported by innovative new polices already exist (in Finland in Denmark, for example) (Saxenian & Sable, 2008; Vartiainen, 2007).

However, in a future digital world, big businesses and big government may play similar roles, as platform managers and curators of ecosystems. Both will provide platforms for the development of business and technological solutions. Governments might work much better as a platform for a set of government services, offering basic building blocks that others can use (and choose between several competing governments) (Economist, 2014) .

The third, digital industrial revolution, globalization of innovation, new structure of global value chance, more open methods of coordination in global business ecosystems, international competition for global entrepreneurs as well as international cooperation fostering the growth of their ventures are just some of the trends that will require profound, even societal changes of national business systems. We've tried to anticipate some of these changes and their effects.

They will need to improve the synergies between industries and the government, leading to new forms of private – public partnerships. The development of new public institutions and policies (essentially re-organising the public sector) and organisation of new private-public partnerships represent a growing need for societal innovation that results from the expansion of open innovation. These areas seem to have the most potential for public societal innovation that can facilitate open mode innovation (Kristensen et al., 2011).

Other socio-political systems also have the capability to influence open innovation adoption and thus represent a growth opportunity for innovative companies. Policy making itself is expected to become more innovative and open. Good examples are 'bottom-up' initiatives and focus on demand – side policies.

Another example of broad, even societal changes needed in support of open innovation is the growing importance of SME's. The current phase of capitalism has shown several trends influencing the development of open innovation systems that could benefit SME's (Economist, 2014). Globalization allowed distributed production and global value chains to develop where contributors all over the world can take part in the economic process (Kristensen et al., 2011). Due to the changes, novel organizational forms are emerging, such as network companies. Some of the challenges of the networked world cannot even be considered from a firm-level perspective, any more than a complex ecosystem can be understood by studying one of its actors, or a chemical reaction can be understood by studying a single reagent.

The rise of networks has fundamental implications for business strategy and competencies. If Michael Porter's Five Forces (M. Porter, 1985) model puts the firm at the centre and other forces outside, the new reality puts the firm and the five forces in the network itself. Concepts such as barriers to entry have less meaning, and the idea of rivalry, buyers, and suppliers is transformed by an environment of "co-opetition". A challenge for large companies is to develop network-centric business models and strategies to harness the power of the broader network. However, the challenge for SMEs is different – how to become a member of such a network. Changing market conditions force smaller firms to adapt or reinvent their business through new technologies and business models. They must collaborate with external and network partners (large and small) to innovate successfully. Open innovation is the logical solution. This often forces them to adopt business model innovation as well. Business model innovation is a crucial part of the open innovation concept (Chesbrough, 2006).

In the new growth and development regime of open and networked innovation systems, SME's are becoming increasingly important components and an opportunity for countries that can support them with progressive policies. There is clear public interest to support the development of open and growing SME's as they will support the enabling welfare state in their later stages of development. Innovative SME's have the potential to become small multinational companies and thus develop into organisational units long deemed as especially fragile (Kristensen et al., 2009; Kristensen & Zeitlin, 2004). The main challenge I discuss in this dissertation - how to support domestic embedding of industrial knowledge development and innovation processes – is closely connected to the success of SME's in becoming innovation hubs in their ecosystem. Small countries that are lacking large domestic markets are better positioned to support such SME's due to their natural

inclination for internationalisation. Flexibly adjusting their policies to support such embedding could also be easier in smaller countries due to the characteristics of the political process. As my research shows, a number of countries with innovation success are actually small and open economies. This could imply that they have the potential to benefit most from embracing open innovation based policy-making. More research on the innovation policy making of smaller countries would be interesting. A good example of national business systems already developing innovative solutions to changing global innovation landscape are Scandinavian countries (Acemoglu et al., 2012). The future research of policy mix adopting to new, open systems of innovation would be advised to first examine their examples.

REFERENCES

1. Aarikka-Stenroos, L., & Sandberg, B. (2012). From new-product development to commercialization through networks. *Journal of Business Research*, *65*(2), 198–206.
2. Acemoglu, D., Robinson, J., & Verdier, T. (2012). *Can t We All Be More Like Scandinavians? Asymmetric Growth and Institutions in an Interdependent World* (No. 18441). *NBER Working paper series* (p. 47). Cambridge, MA 02138.
3. Adam, F. (2014). *Measuring National Innovation Performance*. Berlin, Heidelberg: Springer Berlin Heidelberg.
4. Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review*.
5. Allen, M. M. C., & Aldred, M. L. (2011). Varieties of capitalism, governance, and high-tech export performance: A fuzzy-set analysis of the new EU member states. *Employee Relations*, *33*(4), 334–355.
6. Altmann, P., & Li, J. (2011). *The novelty of Open Innovation* (Vol. 2, pp. 1–24).
7. Anderson, C., & Wolff, M. (2010). The Web Is Dead. Long Live the Internet. *The Wired Magazine*, 5.
8. Arnold, E. (2004). Evaluating research and innovation policy: a systems world needs systems evaluations. *Research Evaluation*, *13*(1), 3–17.
9. Arrow, K. (1962). Economic welfare and the allocation of resources for invention. In *The Rate and Direction of Inventive Activity: Economic and Social Factors* (Vol. I, pp. 609–626).
10. Arrow, K., & Debreu, G. (1954). Existence of an equilibrium for a competitive economy. *Econometrica: Journal of the Econometric Society*, *22*(3), 265–290.
11. Arthur, W. B. (1994). *Increasing Returns and Path Dependence in the Economy* (p. 224). University of Michigan Press.
12. Arvanitis, S., & Hollenstein, H. (1998). Innovative activity and firm characteristics–a cluster analysis with firm-level data of swiss manufacturing. *25th Annual EARIE Conference, …*.
13. Asheim, B. T., & Isaksen, A. (1997). Location, agglomeration and innovation: Towards regional innovation systems in Norway? *European Planning Studies*, *5*(3), 299–330.
14. Astrachan, C. B., Patel, V. K., & Wanzenried, G. (2014). A comparative study of CB-SEM and PLS-SEM for theory development in family firm research. *Journal of Family Business Strategy*, *5*(1), 116–128.
15. Babin, B. J., Hair, J. F., & Bowles, J. S. (2008). Publishing research in marketing journals using structural equation modeling. *Journal of Marketing Theory and Practice*, *16*(4), 279–285.
16. Badawy, M. K. (2011). "Is open innovation a field of study or a communication barrier to theory development?": A perspective. *Technovation*, *31*(1), 65–67.
17. Benoit, G. (2008). Innovation: the History of a Category, Project on the intellectual History of Innovtion. (1), 1–67.
18. Berggren, E. (2013). *Far from an Ivory tower: Researchers as enablers of commercialization*.
19. Birchall, D. W., Chanaron, J. J., & Soderquist, K. (1996). Managing innovation in SMEs: a comparison of companies in the UK, France and Portugal. *International Journal of Technology Management*, *12*(3), 291–305.

20. Blank, S. (2013). Why the lean start-up changes everything. *Harvard Business Review*, (May).
21. Bleda, M., & del Río, P. (2013). The market failure and the systemic failure rationales in technological innovation systems. *Research Policy*, *42*(5), 1039–1052.
22. Bogers, M., & West, J. (2010). Contrasting innovation creation and commercialization within open, user and cumulative innovation. *User and Cumulative Innovation (July 13, 2010 …*, 1–36.
23. Bortoluzzi, G. (2014). *Notes on regional and national cluster policies analysis* (p. 15).
24. Bughin, J., Chui, M., Johnson, B., & Internet, T. (2008). The next step in open innovation. *The McKinsey Quarterly*, (june), 1–8.
25. Carrier, C. (1994). Research note: intrapreneurship in large firms and SMEs: a comparative study. *International Small Business Journal*, *12*(3), 54–61.
26. Černe, M., Jaklič, M., & Škerlavaj, M. (2013). Decoupling management and technological innovations: Resolving the individualism–collectivism controversy. *Journal of International Management*, *19*(2), 103–117.
27. Chandler, A. D. (1962). *Strategy and structure: chapters in the history of industrial enterprise*. Cambridge/Mass.
28. Cherchye, L., Moesen, W., & Van Puyenbroeck, T. (2004). Legitimately Diverse, yet Comparable: On Synthesizing Social Inclusion Performance in the EU. *JCMS: Journal of Common Market Studies*, *42*(5), 919–955.
29. Chesbrough. (2003). *Open innovation: the new imperative for creating and profiting from technology* (p. 227). Harvard Business Press.
30. Chesbrough, H. (2012). Open Innovation: Where We've Been and Where We're Going. *Research-Technology Management*, *55*(4), 20–27.
31. Chesbrough, H., Vanhaverbeke, W., & West, J. (2011). Open innovation and public policy in Europe. *Science Business*, (December).
32. Chesbrough, H. W. (2006). *Open Business Model* (p. 256). Boston: Harvard Business Press.
33. Chesbrough, H. W. (2011). *Open Service Innovation* (p. 256). Jossey-Bass.
34. Chesbrough, H. W., & Crowther, A. K. (2006). Beyond high tech: early adopters of open innovation in other industries. *R&D Management*,
35. Chesbrough, H. W., & Garman, A. R. (2009). How Open Innovation Can Help You in Lean Times. *Harvard Business Review*, 6.
36. Chesbrough, H. W., Vanhaverbeke, W., & West, J. (2006). *Open Innovation: Researching the New Paradigm* (p. 373). Oxford: Oxford University Press.
37. Chiaroni, D., Chiesa, V., & Frattini, F. (2009). The Open Innovation Journey: How firms dynamically implement the emerging innovation management paradigm. *Technovation*, 1–10.
38. Chin, W. W. (2010). How to write up and report PLS analyses. In V. Espozito Vinci, W. W. Chin, J. Hensler, & H. Wang (Eds.), *Handbook of Partial Least Squares: Concepts, Methods, and Applications* (pp. 655–690). Berlin: Springer.
39. Christensen, C. (2013). *The innovator's dilemma: when new technologies cause great firms to fail*.
40. Christensen, C. M., & Raynor, M. E. (2003). *The Innovator's Solution: Creating and Sustaining Successful Growth* (p. 304). Harvard Business Press.
41. Christensen, J., Olesen, M., & Kjar, J. (2005). The industrial dynamics of Open Innovation—Evidence from the transformation of consumer electronics. *Research Policy*, *34*(10), 1533–1549.

42. Clark, J., & Guy, K. (1998). Innovation and competitiveness: a review. *Technology Analysis & Strategic Management*, *10*(3), 363–395.
43. Coase, R. H. (1937). The Nature of the Firm. *Economica*, *4*(16), 386–405.
44. Cohen, W., & Levinthal, D. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), 128–152.
45. Commission, E. (2013a). DG Enterprise and industry - Industrial Innovation.
46. Commission, E. (2013b). DG Enterprise and industry - Innovation Policy.
47. Commission, E. (2013c). Innovation Union - a Europe 2020 Initiative.
48. Cotic-Svetina, A., Jaklic, M., & Prodan, I. (2008). Does collective learning in clusters contribute to innovation? *Science and Public Policy*, *35*(5), 335–345.
49. Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research Policy*, *39*(6), 699–709.
50. Damanpour, F. (1991). Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators. *The Academy of Management Journal*, *34*(3), 555–590.
51. De Backer, K., Cervantes, M., Van De Velde, E., & Martinez, C. (2008). *Open innovation in Global Networks* (Vol. 14, p. 132). Paris.
52. De Backer, K., López-Bassols, V., & Martinez, C. (2008). Open Innovation in a Global Perspective: What Do Existing Data Tell Us? *OECD Science, Technology and Industry Working Papers*.
53. Dejong, J., & Marsili, O. (2006). The fruit flies of innovations: A taxonomy of innovative small firms. *Research Policy*, *35*(2), 213–229.
54. DeSouza, K. (2010). Building Sustainable Collaborative and Open Innovation Programs. In *Research seminar*.
55. Di Gangi, P. M., & Wasko, M. (2009). Steal my idea! Organizational adoption of user innovations from a user innovation community: A case study of Dell IdeaStorm. *Decision Support Systems*, *48*(1), 303–312.
56. Diez, M. A. (2001). The Evaluation of Regional Innovation and Cluster Policies: Towards a Participatory Approach. *European Planning Studies*, *9*(7), 907–923.
57. Ebersberger, B., Herstad, S., Iversen, E., Kirner, E., & Som, O. (2011). *Open Innovation in Europe : effects, determinants and policy*. *Innovation* (p. 235).
58. Economist. (2006). Open, but not usual. *The Economist*.
59. Economist. (2014). *A Cambrian moment - tech startups report* (p. 14).
60. Edquist, C. (2000). Innovation Policy – A Systemic Approach by. In D. Archibugi & B.-Å. Lundvall (Eds.), *The Globalising Learning Economy* (pp. 1–25). Oxford University Press.
61. Edquist, C. (2001). The Systems of Innovation Approach and Innovation Policy: An account of the state of the art. *DRUID Conference, Aalborg*, 1–24.
62. EIU. (2009). *A new ranking of the world ' s most innovative countries: notes on methodology* (p. 11). London.
63. EIU. (2011). *Fostering innovation-led clusters: A review of leading global practices*. *Intelligence* (p. 18).
64. Emmenegger, P. (2013). QCA and Fuzzy Sets: Basic and Advanced Issues in Set-Theoretic Methods. In *QCA Basic Concepts, Fuzzy Sets, Calibration and Software* (p. 57).
65. Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. *R&D Management*, *39*(4), 311–316.
66. EU. (2012). *Innovation Union Scoreboard 2011*. *European Commission, Brussels* (p. 101).
67. Euchner, J. A. (2010). Two flavors of open innovation. *Management Technology*, *4*(Jul), 7–8.

68. Eurostat. (2009). *' High-technology ' and ' knowledge based services ' aggregations based on NACE Rev . 2* (p. 2). Luxembourg.
69. Fagerberg, J. (1994). Technology and international differences in growth rates. *Journal of Economic Literature*.
70. Fagerberger, J. (2005). Innovation: A guide to the literature. In *The Oxford Handbook of Innovation* (p. 656). Oxford University Press.
71. Fagerberger, J., Mowery, D. C., & Nelson, R. R. (2006). *The Oxford Handbook of Innovation* (p. 656). Oxford Handbooks Online.
72. Finger, M., & Stucki, A. (2009). Open Innovation as an Option for Reacting to Reform and Crisis: What Factors Influence the Adoption of Open Innovation? *2nd ISPIM Innovation Symposium*.
73. Fiss, P. (2011). Building better causal theories: a fuzzy set approach to typologies in organization research. *Academy of Management Journal*, *54*(2), 393–420.
74. Fiss, P. (2012). Using Qualitative Comparative Analysis (QCA) and Fuzzy Sets.
75. Fornell, C., & Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50.
76. Frank, R. (2012). *The Darwin economy: liberty, competition, and the common good*. Freeman, C. (1987). *Technology, policy, and economic performance: Lessons from Japan* (p. 155). Pinter Publishers.
77. Freeman, C., & Soete, L. (1997). *The economics of industrial innovation* (3rd ed., p. 585). Routledge.
78. Fundation, N. S. (2012). Chapter 4 Research and Development : National Trends and. In *Science and Engineering Indicators 2012* (pp. 1–58).
79. Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management*, *19*(2), 110–132.
80. Gassmann, O. (2006). Opening up the innovation process: towards an agenda. *R&D Management*, 223–228.
81. Gassmann, O., & Enkel, E. (2004). Towards a theory of open innovation: three core process archetypes. *R&D Management Conference*.
82. Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R&d Management*, 1–9.
83. Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1997). *The new production of knowledge: The dynamics of science and research in contemporary societies* (p. 179).
84. Greenwald, B. C., & Stiglitz, J. E. (1986). Externalities in Economies with Imperfect Information and Incomplete Markets. *The Quarterly Journal of Economics*, *101*(2), 229.
85. Groen, A. J., & Linton, J. D. (2010). Is open innovation a field of study or a communication barrier to theory development? *Technovation*, *30*(11-12), 554–554.
86. Grøtnes, E. (2009). Standardization as open innovation: two cases from the mobile industry. *Information Technology & People*, *22*(4), 367–381.
87. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate Data Analysis* (7th ed.). New York: Prentice Hall.
88. Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science*, *40*(3), 414–433.
89. Hall, P. A., & Soskice, D. (2001). *Varieties of capitalism: The institutional foundations of comparative advantage* (p. 540). New York: Oxford University Press.

90. Harison, E., & Koski, H. (2010). Applying open innovation in business strategies: Evidence from Finnish software firms. *Research Policy*, *39*(3), 351–359.
91. Hayek, F. A. (1945). The use of knowledge in society. *The American Economic Review*, *35*(4), 519–530.
92. Henderson, R., & Cockburn, I. (1996). Scale, Scope and Spillovers: The Determinants of Research Productivity in the Pharmaceutical Industry. *Rand Journal of Economics*, *27*(1), 32–59.
93. Hensler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *Advances in International Marketing*, *20*, 277–319.
94. Herrigel, G. (2010). *Manufacturing Possibilities: Creative Action and Industrial Recomposition in the United States, Germany, and Japan* (p. 292). Oxford University Press.
95. Herstad, S., & Bloch, C. (2008). Open innovation and globalisation: Theory, evidence and implications. *Projektbericht Des ERA- …*, (April).
96. Herstad, S. J., Bloch, C., Ebersberger, B., & van de Velde, E. (2010). National innovation policy and global open innovation: exploring balances, tradeoffs and complementarities. *Science and Public Policy*, *37*(2), 113–124.
97. Hobday, M. (2000). East versus Southeast Asian innovation systems: comparing OEM-and TNC-led growth in electronics. In Technology, Learning, and Innovation: Experiences of Newly Industrializing Economies (p. 377). Cambridge University Press.
98. Hoffman, K., Parejo, M., Bessant, J., & Perren, L. (1998). Small firms, R&D, technology and innovation in the UK: a literature review. *Technovation*, *18*(1), 39–55.
99. Hollanders, H., Es-Sadki, N., & Commission, E. (2013). *Innovation Union Scoreboard 2013. The Innovation Union's performance scoreboard for …* (p. 80).
100. Hollanders, H., & Tarantola, S. (2011). *Innovation Union Scoreboard 2010 – Methodology report* (p. 56).
101. Hollanders, H., & van Cruysen, A. (2008). *Rethinking the European Innovation Scoreboard: A New Methodology for 2008-2010* (p. 44).
102. Hollingsworth, J. R. (1991). The logic of coordination in American manufacturing sectors. In *Governance of the American Economy*.
103. Huizingh, E., Conn, S., & Torkkeli, M. (2011). ISPIM special issue on open innovation. *Technovation*, *31*(1), 1–1.
104. Huizingh, E. K. R. E. (2011). Open innovation: State of the art and future perspectives. *Technovation*, *31*(1), 2–9.
105. Hull Kristensen, P. (2010). Transformative dynamics of innovation and industry: new roles for employees? *Transfer: European Review of Labour and Research*, *16*(2), 171–183.
106. Hult, G. T. M., Hurley, R. F., & Knight, G. a. (2004). Innovativeness: Its antecedents and impact on business performance. *Industrial Marketing Management*, *33*(5), 429–438.
107. Huston, L., & Sakkab, N. (2006). Connect and develop. *Harvard Business Review*, *84*(1), 58–66.
108. Hwang, V. W., & Horowitt, G. (2012). *The Rainforest: The secret to building the next Silicon Valley*. Regenwald.
109. Ioannou, I., & Serafeim, G. (2012). What drives corporate social performance? The role of nation-level institutions. *Journal of International Business …*, *4*, 1–57.
110. Irish Innovation Taskforce. (2010). *Innovation Ireland - Report of teh Innovation Taskforce* (p. 132). Dublin.

111. Jackson, G., & Apostolakou, A. (2010). Corporate Social Responsibility in Western Europe: An Institutional Mirror or Substitute? *Journal of Business Ethics*, *94*(3), 371–394.
112. Jacobs, D. (1998). Innovation policies within the framework of internationalization. *Research Policy*, *27*(7), 711–724.
113. Jaklič, M. (2009). *Poslovno okolje in gospodarski razvoj* (p. 301). Ljubljana: Ekonomska Fakulteta Univerze v Ljubljani.
114. Jaumotte, F., & Pain, N. (2005). An overview of public policies to support innovation, (456).
115. Jensen, M. B., Johnson, B., Lorenz, E., & Lundvall, B. Å. (2007). Forms of knowledge and modes of innovation. *Research Policy*, *36*(5), 680–693.
116. Jensen, M. C. (1993). The Modern Industrial Revolution , Exit , and the Failure of Internal Control Systems The Modern Industrial Revolution , Exit , and the Failure of Internal Control Systems. *Journal of Finance*, 831–880.
117. Kalmi, P., & Sweins, C. (2010). The performance impact of financial participation: subjective and objective measures compared. *Advances in the Economic Analysis of Participatory & Labor-Managed Firms*, *11*, 69–88.
118. Katz, R., & Allen, T. J. (1982). Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R & D Project Groups. *R&D Management*, *12*(1), 7–20.
119. Keizer, J. A., Dijkstra, L., & Halman, J. I. M. (2002). Explaining innovative efforts of SMEs . An exploratory survey among SMEs in the mechanical and electrical engineering sector in The Netherlands, *22*, 1–13.
120. Ketels, C., Lindqvist, G., & Sölvell, Ö. (2006). Cluster initiatives in developing and transition economies. *Center for Strategy and …*.
121. Kirschbaum, R. (2005). Open innovation in practice. *Research-Technology Management*.
122. Klein Woolthuis, R., Lankhuizen, M., & Gilsing, V. (2005). A system failure framework for innovation policy design. *Technovation*, *25*(6), 609–619.
123. Kline, S., & Rosenberg, N. (1986). *An overview of innovation*. *The positive sum strategy: Harnessing …* (pp. 275–304).
124. Kraemer, K. L., Gurbaxani, V., & King, J. L. (1992). Economic development, government policy, and the diffusion of computing in Asia-Pacific countries. *Public Administration Review*, *52*(2), 146–156.
125. Kristensen, P. H., & Lilja, K. (2011). *Nordic capitalisms and globalization: New forms of economic organization and welfare institutions*. Oxford University Press.
126. Kristensen, P. H., Lilja, K., Jaklič, M., & Pustovrh, A. (2011). *Social innovation of open innovation systems around small multinational companies* (p. 86).
127. Kristensen, P. H., Lilja, K., Moen, E., & Jaklic, M. (2009). *New modes of globalizing: experimetnalist forms of economic organization and enabling welfare institutions - lessons from Nordic countris and Slovenia*. TransLearn Project (EU FP6).
128. Kristensen, P. H., & Zeitlin, J. (2004). *Local Players in Global Games: The Strategic Constitution of a Multinational Corporation*. *OUP Catalogue*. Oxford University Press.
129. Kuhn, T. S. (1962). *The Structure of Scientific Revolutions* (Vol. II). University of Chicago Press.
130. Lakatos, I. (1976). Falsification and the methodology of scientific research programmes. In *Can Theories be Refuted?* (pp. 205–259). Springer Netherlands.
131. Lakhani, K. R., & Panetta, J. A. (2007). The principles of distributed innovation. *Innovations: Technology, Governance, Globalization*, *2*(3), 97–112.

132. Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, *27*(2), 131–150.
133. Lazzarotti, V., Manzini, R., & Pellegrini, L. (2010). Open innovation models adopted in practice: an extensive study in Italy. *Measuring Business Excellence*, *14*(4), 11–23.
134. LeBlanc, L. J., Nash, R., Gallagher, D., Gonda, K., & Kakizaki, F. (1997). A comparison of US and Japanese technology management and innovation. *International Journal of Technology Management*, *13*(5), 601–614.
135. Lee, S., Park, G., Yoon, B., & Park, J. (2010). Open innovation in SMEs—An intermediated network model. *Research Policy*, *39*(2), 290–300.
136. Lin, G. T. R., Shen, Y.-C., & Chou, J. (2010b). National innovation policy and performance: Comparing the small island countries of Taiwan and Ireland. *Technology in Society*, *32*(2), 161–172.
137. Lundvall, B. Å. (1992). *National innovation system: towards a theory of innovation and interactive learning*. Pinter Publishers.
138. Lundvall, B.-åke. (1985). *Product Innovation and User-Producer Interaction*.
139. Malerba, F., & Orsenigo, L. (1997). Technological Regimes and Sectoral Patterns of Innovative Activities. *Industrial and Corporate Change*, *6*(1), 83–118.
140. Maliranta, M., Määttänen, N., & Vihriälä, V. (2012). Are the Nordic countries really less innovative than the US?
141. March, J. G. (1991). March 1991.pdf. *Organizational Science*, *2*(1), 71–87.
142. Marshall, A. (1920). The concentration of Specialized Industries in partucular localities. In *Principles of economics* (p. 731).
143. Marx, K. (2004). *Capital: A critique of political economy*. Digireads. com Publishing.
144. Mcphee, C., & Segers, J. (2013). Editorial: Open Innovation and Entrepreneurship. *Technology Innovation Management Review*, (April), 3–5.
145. Mensch, G. (1979). *Stalemate in technology : innovations overcome the depression* (p. 240). Ballinger.
146. Mention, A.-L. (2011). Co-operation and co-opetition as open innovation practices in the service sector: Which influence on innovation novelty? *Technovation*, *31*(1), 44–53.
147. Milgrom, P. R., & Roberts, J. (1992). *Economics, Organization and Management* (p. 621).
148. Moore, J. F. (1993). Predators and pray: A New Ecology of Competition. *Harvard Business Review*, *71*(3), 75–86.
149. Morec, B., & Rašković, M. (2011). Overview and estimation of the 2008 financial and economic crisis 'effect size' on SME capital structures: case of Slovenia. *Ekonomska Istraživanja*, *24*(4), 107–126.
150. Morgan, G. (2007). National business systems research: Progress and prospects. *Scandinavian Journal of Management*, *23*(2), 127–145.
151. Mowery, D. C. (1983). The relationship between intrafirm and contractual forms of industrial research in American manufacturing, 1900-1940. *Explorations in Economic History*, *20*(4), 351–374.
152. MVZT, M. za visoko šolstvo znanost in tehnologijo. (2011). *Raziskovalna in inovacijska strategija Slovenije 2011–2020* (p. 63).
153. Nagaretham, R. (2012). Comparison of key enablers for the successful comercialization of bioinformatics products in Malaysia and Singapore. *International Journal of …*, *1*(2), 158–175.

154. Nelson, R. R. (1993). *National innovation systems: a comparative analysis* (p. 541), Oxford University Press.
155. Nelson, R. R., & Winter, S. G. (1982). *An evolutionary theory of economic change* (p. 437).
156. Nerkar, A., & Shane, S. (2007). Determinants of invention commercialization: An empirical examination of academically sourced inventions. *Strategic Management Journal*, *1166*(April 2002), 1155–1166.
157. Nill, J., & Kemp, R. (2009). Evolutionary approaches for sustainable innovation policies: From niche to paradigm? *Research Policy*, *38*(4), 668–680.
158. OECD. (2004). *Benchmarking Innovation Policy and Innovation Framework Conditions* (p. 41).
159. OECD. (2005). *Oslo Manual*. *Guidelines for Collecting and Interpreting Innovation …*.
160. *OECD Reviews of Innovation Policy: Slovenia*. (2012) (p. 182).
161. *OECD Science, Technology and Industry Scoreboard*. (2013) (p. 279).
162. Oerlemans, L. a. G., Meeus, M. T. H., & Boekema, F. W. M. (1998). Do Networks Matter for Innovation? The usefulness of the economic network approach in analysing innovation. *Tijdschrift Voor Economische En Sociale Geografie*, *89*(3), 298–309.
163. Owens, T., & O., F. (2014). *The Lean Enterprise: How Corporations Can Innovate Like Startups*. John Wiley & Sons.
164. P., K. (1979). A Model of Innovation, Technology Transfer, and the World Distribution of Income. *Journal of Political Economy*, *87*(2), 253–266.
165. Palmberg, C. (2006). The sources and success of innovations —Determinants of commercialisation and break-even times. *Technovation*, *26*(11), 1253–1267.
166. Parida, V., Westerberg, M., & Frishammar, J. (2012). Inbound Open Innovation Activities in High-Tech SMEs: The Impact on Innovation Performance. *Journal of Small …*, *50*(2), 283–309.
167. Pavitt, K. (1984). Sectoral patterns of technical change : Towards a taxonomy and a theory. *Research Policy*, *13*(1984), 343–373.
168. Pavitt, K. (1998). Technologies, Products and Organization in the Innovating Firm: What Adam Smith Tells Us and Joseph Schumpeter Doesn't. *Industrial and Corporate Change*, *7*(3), 433–452.
169. Pearce, J. M., Morris Blair, C., Laciak, K. J., Andrews, R., Nosrat, A., & Zelenika-Zovko, I. (2010). 3-D Printing of Open Source Appropriate Technologies for Self-Directed Sustainable Development. *Journal of Sustainable Development*, *3*(4), p17.
170. Penrose, E. T. (1952). Biological Analogies in the Theory of the Firm. *The American Economic Review*, *42*(5), 804–819.
171. Penrose, E. T. (1995). *The Theory of the Growth of the Firm, Oxford University Press*, (p. 272).
172. Perez, C. (1983). Structural change and assimilation of new technologies in the economic and social systems. *Futures*, *15*(5), 357–375.
173. Porter, M. (1985). Competitive advantage : creating and sustaining superior performance , Simon and Schuster , (p. 557).
174. Porter, M. (1990). The competitive advantage of nations. *Harvard Business Review*, *68*(2), 73–93.
175. Porter, M. (1998). *Clusters and the new economics of competition*. *Harvard Business Review*, *76*(6), 77–99.
176. Porter, M. (2008). Clusters, innovation and competitiveness: new findings and implications for policy. In *Presidency Conference on Innovation and Clusters*.

177. Posner, M. V. (1961). International trade and technical change. *Oxf. Econ. Pap.*, *13*(3), 323–341.
178. Praest Knudsen, M., & Bøtker Mortensen, T. (2011). Some immediate – but negative – effects of openness on product development performance. *Technovation*, *31*(1), 54–64.
179. Pustovrh, A., & Jaklič, M. (2014). National innovation policies in the EU: a fuzzy-set analysis. *Economic and Business Review*, 16 (1), 39-62
180. Radas, S., & Božić, L. (2009). The antecedents of SME innovativeness in an emerging transition economy. *Technovation*, *29*(6-7), 438–450.
181. Ragin, C. C. (1987). *The comparative method* (p. 181). University of California Press.
182. Ragin, C. C. (2000). *Fuzzy-set social science* (p. 350). University of Chicago Press.
183. Ragin, C. C. (2006). Set Relations in Social Research: Evaluating Their Consistency and Coverage. *Political Analysis*, *14*(3), 291–310.
184. Ragin, C. C. et al. (2007). *Družboslovno raziskovanje - enotnost in raznolikost metode* (p. 201). Fakulteta za družbene vede.
185. Ragin, C. C., Kriss, A. D., & Davey, S. (2006). Fuzzy-Set/Qualitative Comparative Analysis 2.0. Tuscon, Arizona: University of Arizona, Department of Sociology.
186. Ragin, C. C., & Rihoux, B. (2009). *Configurational Comparative Methods* (p. 185). Sage.
187. Rammer, C., & (ZEW), C. for E. E. R. (2005). *Comments on EIS Improvements for 2005*.
188. Rašković, M. M., Pustovrh, A., Jaklič, M., & Brenčič, M. (2011). Stanje : pasivni opazovalci , ne proaktivni soustvarjalci novih priložnosti. *Glas Gospodarstva*, (5), 28 – 20.
189. Rašković, M., Pustovrh, A., & Jaklič, M. (2012). Pregled dejavnikov delovanja malih in srednje velikih visokotehnoloških podjetij v Sloveniji. *IB Revija*, *XLVI*(3-4), 39–53.
190. Rašković, M., Pustovrh, A., Jaklič, M., & Makovec Brenčič, M. (2011). Financiranje malih in srednje velikih visokotehnoloških podjetij v Sloveniji. *Bančni Vestnik*, *4*, 38 – 46.
191. Rhee, J., Park, T., & Lee, D. H. (2010). Drivers of innovativeness and performance for innovative SMEs in South Korea: Mediation of learning orientation. *Technovation*, *30*(1), 65–75.
192. Ries, E. (2011). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*. Random House LLC.
193. Rihoux, B., & Grimm, H. (2006). *Innovative Comparative Methods for Policy Analysis* (p. 358). Springer.
194. Ringle, C. M., Wende, S., & Will, A. (2005). SmartPLS. Hamburg. Retrieved from http://www.smartpls.de
195. Rohrbeck, R., Hoelzle, K., & Gemünden, H. G. (2009). Opening Up for Competitive Advantage – How Deutsche Telekom Creates an Open Innovation Ecosystem. *R&D Management*, (39), 420–430.
196. Rosenberg, N. (1982). *Inside the Black Box: Technology and Economics* (p. 304). Cambridge University Press.
197. Roussel, P. A., Saad, K. N., & Erickson, T. J. (1991). *Third generation R&D: managing the link to corporate strategy* (p. 192). Harvard Business Press.
198. Rufat-Latre, J., Muller, A., & Jones, D. (2010). Delivering on the promise of open innovation. *Strategy & Leadership*, *38*(6), 23–28.
199. Sabel, C., & Piore, M. J. (1984). The second industrial divide: possibilities for prosperity (p. 355). New York, Basic Book.

200. Sarkar, S., & Costa, A. (2008). Dynamics of open innovation in the food industry. *Trends in Food Science & Technology*, *19*(11), 574–580.
201. Saxenian, A. (1994). *Regio*nal advantage: Culture and Competition in Silicon Valley and Route 128 (p. 226), 1994. Harvard University, Cambridge, MA.
202. Saxenian, A. (2007). *The New Argonauts: Regional Advantage in a Global Economy* (p. 424). Harvard University Press.
203. Saxenian, A., & Sable, C. (2008). *A Fugitive Success - Finland's Economic future* (p. 126). Helsinki.
204. Schibany, A., & Streicher, G. (2008). The European Innovation Scoreboard: drowning by numbers? *Science and Public Policy*, *35*(10), 717–732.
205. Schneider, C. Q., & Wagemann, C. (2012). Set-theoretic Methods for the Social Sciences (p. 350). Cambridge University Press Textbooks
206. Schneider, C., & Wagemann, C. (2006). Reducing complexity in Qualitative Comparative Analysis (QCA): Remote and proximate factors and the consolidation of democracy. European Journal of Political Research, 45(5), 751-786.
207. Schoeman, M., Baxter, D., Goffin, K., & Micheli, P. (2012). Commercialization partnerships as an enabler of UK public sector innovation: the perfect match? *Public Money & Management*, *32*(6), 425–432.
208. Schumpeter, J. A. (1934). *The Theory of Economic Development: An Inquiry Into Profits, Capital, Credit, Interest, and the Business Cycle* (p. 255). Transaction Publishers.
209. Schumpeter, J. A. (2013). *Capitalism, socialism and democracy* (p. 437). Routledge
210. Scotchmer, S. (1991). Standing on the Shoulders of Giants. *The Journal of Economic Perspectives*, *5*(1), 29–41.
211. Scotchmer, S. (2004). *Innovation and incentives*. MIT Press.
212. Slater, S. F., & Narver, J. C. (1995). Market Orientation and the Learning Organization. *Journal of Marketing*, *59*(3), 63–74.
213. Smith, A., & Garnier, M. (1845). An Inquiry into the Nature and Causes of the Wealth of Nations. T. Nelson and Sons.
214. Sosik, J. J., Kahai, S. S., & Piovoso, M. J. (2009). Silver Bullet or Voodoo Statistics?: A Primer for Using the Partial Least Squares Data Analytic Technique in Group and Organization Research. *Group & Organization Management*, *34*(1), 5–36.
215. Sousa, M. (2008). Open innovation models and the role of knowledge brokers. *Inside Knowledge*, 18–22.
216. Spithoven, A., Clarysse, B., & Knockaert, M. (2010). Building absorptive capacity to organise inbound open innovation in traditional industries. *Technovation*, *30*(2), 130–141.
217. Švarc, J. (2006). Socio-political factors and the failure of innovation policy in Croatia as a country in transition. *Research Policy*, *35*(1), 144–159.
218. Taylor, M. Z. (2004). Empirical Evidence Against Varieties of Capitalism's Theory of Technological Innovation. *International Organization*, *58*(03).
219. Technology, P. C. O. A. O. S. A. (2010). *Report to the President and the Congress on the Third Assessment of the National Nanotechnology Initiative* (Vol. 4, p. 96). Washington.
220. Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, *15*(6), 285–305.
221. The Economist, B. B. (2012). Difference engine: Free is too expensive. *The Economist*, (March 30th).
222. Tsai, K. H., & Yang, S. Y. (2013). Firm innovativeness and business performance: The joint moderating effects of market turbulence and competition. Industrial Marketing Management , 42(8), 1279-1294

223. Tsangari, H., & Vrontis, D. (2012). Innovativeness of European SMEs: mission not yet accomplished. *Ekonomska Istraživanja*, *25*(3), 333–360.
224. Van de Ven, A. H., Polley, D. E., Garud, R., & Venkatarman, S. (1999). *The innovation journey* (p. 422). New York: Oxford University Press.
225. Van De Vrande, V., de Jong, J. P. J., Vanhaverbeke, W., & de Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, *29*(6-7), 423–437.
226. Van de Vrande, V., de Jong, J. P. J., Vanhaverbeke, W., & de Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, *29*(6-7), 423–437.
227. Van der Meer, W., Trommelen, G., Vleggaar, J., & Vriezen, P. (1996). Collaborative R&D and European Industry. *Research Technology Management*, *39*(5), 15–18.
228. Vanhaverbeke, W. (2013). Rethinking Open Innovation Beyond the Innovation Funnel, (April), 6–10.
229. Vanhaverbeke, W., Ine, V., & De Zutter, S. (2012). *Open innovation in SMEs : How can small companies and start-ups benefit from open innovation strategies ?* (p. 99).
230. Vartiainen, J. et al. (2007). The Nordic Model: Embracing Globalization and Sharing Risks. *Society*.
231. Veblen, T. (1898). *Why is economics not an evolutionary science? The Quarterly Journal of Economics 12.4 (1898): 373-397.*
232. Veblen, T. (1899). *The Theory of the Leisure Class. Oxford University Press.*
233. Vernon, R. (1966). International investment and international trade in the product cycle. The quarterly journal of economics, 190-207.
234. Von Hippel, E. (1986). Lead Users: A Source of Novel Product Concepts. *Management Science*, *32*(7), 791–805.
235. Von Hippel, E. (2005). *Democratizing innovation*. MIT Press.
236. Wallin, M. W., & Von Krogh, G. (2010). Organizing for Open Innovation:Focus on the Integration of Knowledge. *Organizational Dynamics*, *39*(2), 145–154.
237. Wernerfelt, B. (1984). A Resource-based View of the Firm. *Strategic Management Journal*, *5*(2), 171–180.
238. West, J. (2009). Policy Challenges of Open, Cumulative, and User Innovation. *Wash. UJL & Pol'y*, 1–20.
239. West, J. (2012). Cumulative, open and user innovation.
240. West, J. (2013). Retraction count reaches lucky 13.
241. Whitley, R. (2000). The Institutional Structuring of Innovation Strategies: Business Systems, Firm Types and Patterns of Technical Change in Different Market Economies. *Organization Studies*, *21*(5), 855–886.
242. Williamson, O., E. (1975). *Markets and Hierarchies: Analysis and Antitrust Implications: A Study in the Economics of Internal Organization* (p. 286).
243. Wooldridge, A. (2010). The world turned upside down - special report on innovation. *The Economist*, *April 17*,.
244. Ye, J., & Kankanhalli, A. (2013). Exploring innovation through open networks: A review and initial research questions. *IIMB Management Review*, *25*(2), 69–82.

APPENDIXES

TABLE OF APPENDIXES

Appendix A: Questionnaire items measuring individual constructs (Chapter 2)

Construct	Question in the questionnaire
INTERNAL FACTORS	**Please estimate the availability of the following internal factors supporting high-tech SME's in Slovenia on a 7 point scale (1-very bad availability, 7-very good availability):**
	• Strategic focus and explicitness of company strategy • Active top management support (through assets, activities etc.) • Existence of an independent innovation strategy • Availability of internal R&D activities including finances • Organizational structure of the company (e.g. innovation project teams) • Internal availability of human resources • Internal system of employee motivation • Innovation output controlling system • Establishment of internal organizational culture of innovation and creativity • Time for experimentation, innovation and creativity • Connection between marketing and R&D functions
EXTERNAL FACTORS	**Please estimate the availability of the following external factors supporting high-tech SME's in Slovenia on a 7 point scale (1-very bad availability, 7-very good availability):**
	• Availability of human resources on the labour market • Infrastructure • Availability of technology and materials
OPEN INNOVATION – INFORMATION EXCHANGE	**Please state the sources of information that have lead you to innovations in the 7 point scale (1-Never, 2-very rarely, in less than 10 % of cases,7-Very often, in more than 80 % of cases):**
	• Technology transfer offices • Entrepreneurship incubators • Research partners • Conference and business fair visits • Scientific publications
OPEN INNOVATION – COLLABORATION	**Please state your innovation collaboration with other companies. Do you collaborate with the following partners in the field of innovation (please tick the box in front of the partners that you collaborate in innovation):**
	• Collaboration with suppliers of equipment, spare parts and/or software • Collaboration with customers of your products or services • Collaboration with consultants, commercial labs, private R&D institutions • Collaboration with universities or high schools
	The first option was that the companies do not collaboratively innovate with these partners groups. The second option was that they do innovate collaboratively with partners in Slovenia. The second option was that they do innovate collaboratively with partners in the EU. The second option was that they do innovate collaboratively with partners in ex-Yugoslavia. The second option was that they do innovate collaboratively with partners in the USA. The second option was that they do innovate collaboratively with partners in other countries. *(Multiple option choice was allowed).*
INNOVATION FACILITATING ACTIVITIES	**Which innovation activities did you use in the past 3 years in your company? Use the 7 point scale (1-Never, 2-very rarely, in less than 10 % of cases,7-Very often, in more than 80 % of cases):**
	• Perceived support for product and process innovation • External R&D usage for internal innovation • Presentation of external knowledge to internal R&D personnel • Establishment of special departments for individual innovations • Changes to the organisational structure of the company to boost innovation

Construct	Question in the questionnaire
INNOVATIVENESS	**Please estimate the 'soft' and 'hard' aspects of innovativeness on a 7 point scale (1-I disagree, 7-I agree):**
	• Support for technical innovations based on research findings • Following and measuring R&D activities and outcomes • Capability to implement fast changes in design of product, service, process • Capability for technological changes in processes based on market demands • Capability of technological changes in products and services based on market demands • Focus on new product development • Focus on new service development
COMMERCIALIZA -TION ENABLERS	**How often did you use the following activities in the past 3 years to support the commercialization of innovation? Use the 7 point scale (1-Never, 2-very rarely, in less than 10 % of cases,7-Very often, in more than 80 % of cases):**
	• Connections with existing external partners (e.g. suppliers) • Development of new business models • Acquiring new business models from another company • Finding new external strategic partner

Appendix B: Uncalibrated data on IUS indices (Chapter 3)

2010 VALUES (original normalised scores)	Summary Innovation Index	Human resources	Research systems	Finance and support	Firm investments	Linkages & entrepreneurship	Intellectual assets
Belgium	0,625	0,657	0,761	0,597	0,471	0,733	0,511
Czech Republic	0,400	0,509	0,283	0,294	0,419	0,429	0,257
Denmark	0,704	0,633	0,777	0,674	0,564	0,813	0,875
Germany	0,711	0,605	0,544	0,597	0,695	0,629	0,799
Estonia	0,492	0,532	0,326	0,646	0,631	0,607	0,349
Ireland	0,571	0,746	0,631	0,359	0,501	0,533	0,446
Greece	0,339	0,450	0,298	0,206	0,220	0,466	0,138
Spain	0,410	0,405	0,539	0,497	0,264	0,261	0,401
France	0,540	0,670	0,656	0,656	0,349	0,470	0,477
Italy	0,429	0,426	0,398	0,386	0,438	0,305	0,517
Luxembourg	0,651	0,747	0,534	0,635	0,505	0,547	0,647
Hungary	0,333	0,430	0,246	0,262	0,324	0,203	0,267
Netherlands	0,595	0,631	0,820	0,710	0,235	0,585	0,679
Austria	0,626	0,581	0,613	0,498	0,502	0,743	0,753
Poland	0,304	0,584	0,153	0,338	0,313	0,187	0,243
Portugal	0,426	0,438	0,447	0,549	0,417	0,356	0,346
Slovenia	0,499	0,602	0,410	0,542	0,557	0,602	0,425
Slovakia	0,322	0,563	0,160	0,146	0,460	0,205	0,168
Finland	0,708	0,877	0,593	0,832	0,639	0,900	0,643
Sweden	0,766	0,880	0,795	0,911	0,666	0,849	0,788
United Kingdom	0,599	0,698	0,784	0,749	0,470	0,551	0,469
Norway	0,485	0,663	0,817	0,656	0,213	0,567	0,305
Switzerland	0,818	0,820	1,000	0,666	0,713	0,709	0,952

Appendix C: Loadings of constructs for CFA and SEM analysis (Chapter 2)

???	Commercialization activities	External factors	Innovation activities	Inovativness	Internal factors	Open Innovation Collaboration	Open Innovation Information Sources
A8c	0	0	0,6932	0	0	0	0
A8d	0	0	0,7064	0	0	0	0
A8e	0	0	0,6747	0	0	0	0
A8f	0	0	0,7039	0	0	0	0
A8g	0	0	0,7343	0	0	0	0
B10b	0	0,6114	0	0	0	0	0
B10d	0	0,8117	0	0	0	0	0
B10h	0	0,8519	0	0	0	0	0
B11a	0	0	0	0	0,7743	0	0
B11b	0	0	0	0	0,7538	0	0
B11c	0	0	0	0	0,8111	0	0
B11d	0	0	0	0	0,8776	0	0
B11f	0	0	0	0	0,7271	0	0
B11g	0	0	0	0	0,8254	0	0
B11i	0	0	0	0	0,8291	0	0
B11j	0	0	0	0	0,7679	0	0
B11l	0	0	0	0	0,7987	0	0
B11m	0	0	0	0	0,8633	0	0
B11n	0	0	0	0	0,6822	0	0
B11o	0	0	0	0	0,7953	0	0
C16h	0	0	0	0	0	0	0,7571
C16i	0	0	0	0	0	0	0,753
C16k	0	0	0	0	0	0	0,765
C16m	0	0	0	0	0	0	0,8089
C16n	0	0	0	0	0	0	0,8049
C17c	0,7874	0	0	0	0	0	0
C17d	0,854	0	0	0	0	0	0
C17e	0,7343	0	0	0	0	0	0
C17f	0,7635	0	0	0	0	0	0
Q2a	0	0	0	0,7144	0	0	0
Q3b	0	0	0	0,7456	0	0	0
Q3c	0	0	0	0,7902	0	0	0
Q3d	0	0	0	0,8331	0	0	0
Q3e	0	0	0	0,7969	0	0	0
Q3g	0	0	0	0,8118	0	0	0
Q3h	0	0	0	0,7295	0	0	0
Q5b	0	0	0	0	0	0,7441	0
Q5c	0	0	0	0	0	0,7969	0
Q5e	0	0	0	0	0	0,7246	0
Q5f	0	0	0	0	0	0,6567	0

Appendix D: Cross-Loadings of constructs for CFA and SEM analysis (Chapter 2)

	Commercialization activities	External factors	Innovation activities	Inovativness	Internal factors	Open Innovation Collaboration	Open Innovation Information Sources
A8c	0,2317	0,2844	**0,6932**	0,3259	0,163	0,1259	0,0963
A8d	0,1564	0,1551	**0,7064**	0,3382	0,3022	0,3184	0,2491
A8e	0,3615	0,2568	**0,6747**	0,3376	0,2501	0,2017	0,3025
A8f	0,3634	0,1	**0,7039**	0,3483	0,1518	0,1096	0,2381
A8g	0,3637	0,1181	**0,7343**	0,3126	0,2624	0,1245	0,1462
B10b	0,0847	**0,6114**	0,0311	0,1642	0,2807	0,079	-0,0358
B10d	0,0661	**0,8117**	0,2704	0,271	0,3624	0,1364	-0,0407
B10h	0,0822	**0,8519**	0,2319	0,3738	0,2589	0,1883	0,0434
B11a	0,3956	0,307	0,2731	0,3875	**0,7743**	0,311	0,2387
B11b	0,2492	0,1594	0,1925	0,3817	**0,7538**	0,1775	0,1736
B11c	0,1928	0,3441	0,2901	0,418	**0,8111**	0,331	0,1387
B11d	0,2546	0,3417	0,3145	0,3877	**0,8776**	0,29	0,178
B11f	0,3278	0,2794	0,2357	0,3892	**0,7271**	0,24	0,2204
B11g	0,3459	0,28	0,1982	0,3907	**0,8254**	0,2114	0,1421
B11i	0,2477	0,3051	0,3183	0,4039	**0,8291**	0,1985	0,0393
B11j	0,2789	0,205	0,2212	0,3636	**0,7679**	0,2606	0,2215
B11l	0,3424	0,4154	0,3279	0,3416	**0,7987**	0,212	0,2128
B11m	0,3092	0,3159	0,2813	0,3776	**0,8633**	0,2643	0,1795
B11n	0,0866	0,2398	0,1177	0,3364	**0,6822**	0,1621	-0,0476
B11o	0,2161	0,2977	0,2116	0,3397	**0,7953**	0,2991	0,1165
C16h	0,4656	-0,0368	0,173	-0,0689	-0,0019	0,0025	**0,7571**
C16i	0,4335	0,0275	0,1209	-0,064	0,0417	0,0292	**0,753**
C16k	0,4465	-0,0046	0,2398	0,0461	0,1619	0,1869	**0,765**
C16m	0,3489	0,0483	0,2785	0,1284	0,2101	0,238	**0,8089**
C16n	0,4801	-0,0352	0,2902	0,1695	0,2413	0,0976	**0,8049**
C17c	**0,7874**	0,0269	0,2575	0,2747	0,2389	0,2195	0,3911
C17d	**0,854**	0,1356	0,4847	0,3494	0,3346	0,0565	0,487
C17e	**0,7343**	0,1263	0,2833	0,174	0,2669	0,1782	**0,5127**
C17f	**0,7635**	0,0093	0,228	0,2119	0,2432	0,1036	0,3614
Q2a	0,0962	0,3457	0,3304	**0,7144**	0,3421	0,3193	-0,0547
Q3b	0,3718	0,3521	**0,5202**	**0,7456**	0,4579	0,2864	0,2021
Q3c	0,2546	0,1643	0,3092	**0,7902**	0,354	0,3044	0,0277
Q3d	0,3122	0,2034	0,3547	**0,8331**	0,2455	0,349	0,1063
Q3e	0,1171	0,2948	0,2653	**0,7969**	0,3777	0,2473	-0,0432
Q3g	0,2341	0,2954	0,3971	**0,8118**	0,3829	0,2275	-0,0137
Q3h	0,3552	0,3543	0,3038	**0,7295**	0,3721	0,0996	0,1609
Q5b	0,124	-0,0245	0,1706	0,2529	0,192	**0,7441**	0,1756
Q5c	0,1078	0,1639	0,0501	0,3048	0,2587	**0,7969**	0,0417
Q5e	0,1973	0,3573	0,4235	0,191	0,3612	**0,7246**	0,2245
Q5f	0,074	0,1025	0,2115	0,2234	0,1295	**0,6567**	0,084

Appendix E: Calibrated data on IUS indices (Chapter 3)

	Summary Innovation Index	Human resources	Research systems	Finance and support	Firm investments	Linkages & entrepreneurship	Intellectual assets
country	**ius_c**	**hr_c**	**rs_c**	**fs_c**	**fi_c**	**la_c**	**ia_c**
BE	0,94	0,96	1	0,72	0,85	1	0,57
CZ	0,25	0,6	0,06	0,04	0,64	0,61	0,04
DK	0,99	0,94	1	0,9	0,98	1	1
DE	0,99	0,9	0,81	0,72	1	0,99	1
EE	0,56	0,69	0,11	0,85	1	0,99	0,12
IE	0,85	0,99	0,96	0,09	0,92	0,94	0,34
GR	0,12	0,37	0,08	0,02	0,05	0,78	0,01
ES	0,27	0,24	0,79	0,37	0,1	0,08	0,22
FR	0,76	0,97	0,97	0,87	0,31	0,79	0,44
IT	0,33	0,3	0,26	0,13	0,73	0,15	0,6
LU	0,96	0,99	0,77	0,83	0,93	0,95	0,94
HU	0,11	0,31	0,04	0,03	0,23	0,03	0,04
NL	0,9	0,93	1	0,94	0,06	0,98	0,97
AT	0,94	0,85	0,94	0,37	0,92	1	0,99
PL	0,08	0,86	0,01	0,07	0,2	0,03	0,03
PT	0,32	0,33	0,42	0,53	0,62	0,29	0,12
SI	0,59	0,89	0,3	0,5	0,98	0,99	0,28
SK	0,1	0,8	0,01	0,01	0,82	0,03	0,01
FI	0,99	1	0,91	0,99	1	1	0,94
SE	1	1	1	1	1	1	1
UK	0,9	0,98	1	0,97	0,85	0,96	0,41
NO	0,53	0,96	1	0,87	0,04	0,97	0,07
CH	1	1	1	0,89	1	1	1

Appendix F: Fuzzy scores of IUS indices, used in the analysis (Chapter 3)

	Summary Innovation Index	Human resources	Research systems	Finance and support	Firm investments	Linkages & entrepreneurship	Intellectual assets
BE	1	1	1	0,66	0,66	1	0,66
CZ	0,33	0,33	0	0	0,66	0,66	0
DK	1	0,66	1	1	1	1	1
DE	1	0,66	0,66	0,66	1	1	1
EE	0,66	0,33	0	1	1	1	0,33
IE	1	1	1	0	0,66	1	0,33
GR	0	0	0	0	0	0,66	0
ES	0,33	0	0,66	0,33	0	0	0,33
FR	0,66	1	1	1	0,33	0,66	0,66
IT	0,33	0	0,33	0	0,66	0,33	0,66
LU	1	1	0,66	1	0,66	1	1
HU	0	0	0	0	0,33	0	0
NL	1	0,66	1	1	0	1	1
AT	1	0,66	1	0,33	0,66	1	1
PL	0	0,66	0	0	0,33	0	0
PT	0,33	0	0,33	0,33	0,66	0,33	0,33
SI	0,66	0,66	0,33	0,33	1	1	0,33
SK	0	0,33	0	0	0,66	0	0
FI	1	1	1	1	1	1	1
SE	1	1	1	1	1	1	1
UK	1	1	1	1	0,66	1	0,66
NO	0,66	1	1	1	0	1	0
CH	1	1	1	1	1	1	1

Appendix G: Uncalibrated data on narrow and broad policies supporting innovation (Chapter 4)

country	health_raw	whohealth_raw	pension_raw	labour_raw	timetax_raw	wtitax_raw	openinvest_raw	educ_raw	gerd_raw	industryherd_ra	triadicpatent_r	industrygerd_ra	rdpersonell_raw
AT	80,7	9	58,899	24	170	0,55	88,481	487	1,08	13,81	36,12	1,25	5,2
BE	80,3	21	59,7522	17	156	0,67	383,427	509	0,51	12,03	27,94	1,19	10,99
CH	82,6	20	64,2981	7	63	0,35	282,896	517	0,66	9,14	90,28	1,96	9,14
Chile	79	33	67,9	18	291	0,36	94,228	439	0,16	1,48	0,55	0,15	6,39
China	73,3	144	55	31	318	0,6	30,136	577	0,42	3,26	0,57	1,26	33,23
CZ	77,7	48	60,6292	11	613	0,43	72,558	490	0,62	9,92	1,81	0,76	1,07
DE	80,5	25	61,5739	42	196	0,4	70,609	499	0,85	13,16	60,29	1,84	13,94
DK	79,3	34	62,9426	7	135	0,8	107,617	499	0,83	19,72	40,83	1,86	3,17
EE	75,6	77	64,1241	51	81	0,53	116,956	514	0,72	7,66	2,22	0,71	4,16
ES	82,2	7	62,6872	49	213	0,53	92,796	484	0,65	9,62	3,58	0,6	7,88
FI	80,2	31	61,6583	41	243	0,59	93,904	544	1	20,78	50,82	2,58	5,71
FR	81,4	1	59,43	52	132	0,5	96,834	497	0,83	13,87	32,06	1,2	1,97
HU	74,3	66	59,6318	22	330	0,64	86,427	496	0,46	7,4	3,5	0,55	13,56
IE	81	19	63,6404	10	76	0,38	288,396	497	0,5	8,97	14,68	0,89	2,3
Israel	81,7	28	66,3	17	33	0,43	59,422	459	0,67	9,66	36,64	1,75	9,66
IT	82	2	59,8201	38	314	0,5	39,842	486	0,53	9,03	9,87	0,56	1,07
Japan	83	10	68,6	16	330	0,39	19,058	529	0,56	13,24	103,62	2,47	2,63
Korea	80,7	58	70,4	38	187	0,37	27,332	541	1	13,55	33,6	2,68	11,28
LU	80,7	16	58,1741	56	59	0,49	624,606	482	0,52	13,3	25,26	0,66	0,13
NL	80,8	17	62,1795	42	164	0,58	195,357	519	0,74	11,44	46,88	0,82	8,23
NO	81,2	11	63,9729	44	87	0,63	86,851	500	0,82	13,88	19,98	0,77	3,81
PL	76,3	50	60,3241	25	395	0,51	51,097	501	0,45	4,78	0,42	0,18	2,92
PT	79,8	12	65,584	43	328	0,44	78,017	490	0,71	9,38	0,88	0,7	0,64
Russia	69	130	61,4	38	177	0,5	57,603	468	0,8	11,13	0,32	0,29	24,53
SE	81,5	23	64,8288	38	122	0,5	155,5	495	0,99	15,65	73,14	2,12	4,49
SI	79,5	38	59,716	54	260	0,56	48,27	499	0,74	12,42	3,37	1,22	12,03
SK	75,2	62	58,3732	22	257	0,4	61,578	488	0,31	6,72	0,57	0,22	2,33
Taiwan	79,2	39	56,6	46	221	0,5	59,27	519	0,8	19,03	10,6	2,08	6,67
UK	80,6	18	63,0085	10	110	0,52	123,335	500	0,58	11,19	22,39	0,79	4,11
USA	78,8	37	65,4	0	175	0,41	47,792	496	0,92	5,21	40,14	1,73	5,21

Appendix H: Calibrated data on narrow and broad policies supporting innovation (Chapter 4)

country	health_calib	whohealth_calib	pension_calib	labour_calib	timetax_calib	wtitax_calib	openinvest_cali	educ_calib	gerd_calib	industryherd_calib	triadic_calib	industrygerd_calib	personell_calib	iussi2013_calib
AT	0,74	0,05	0,01	0,83	0,46	0,68	0,39	0,31	0,97	0,76	0,7	0,68	0,51	0,66
BE	0,61	0,08	0,03	0,91	0,49	0,93	0,99	0,63	0,34	0,63	0,63	0,64	0,77	0,66
CH	0,98	0,08	0,91	0,96	0,93	0,1	0,94	0,73	0,61	0,38	0,95	0,95	0,7	1
Chile	0,35	0,11	1	0,9	0,23	0,11	0,44	0,03	0,04	0,04	0,05	0,01	0,57	0,33
China	0,02	0,84	0	0,71	0,19	0,82	0,06	0,99	0,21	0,07	0,05	0,69	1	0
CZ	0,2	0,17	0,11	0,95	0,02	0,26	0,25	0,35	0,54	0,45	0,06	0,19	0,05	0,33
DE	0,68	0,09	0,35	0,35	0,4	0,18	0,24	0,49	0,87	0,72	0,86	0,93	0,86	1
DK	0,4	0,12	0,72	0,96	0,61	0,99	0,53	0,49	0,85	0,96	0,74	0,93	0,2	1
EE	0,07	0,35	0,89	0,04	0,89	0,61	0,56	0,7	0,71	0,27	0,07	0,15	0,35	0,66
ES	0,96	0,05	0,67	0,06	0,37	0,61	0,43	0,28	0,59	0,42	0,09	0,08	0,64	0,33
FI	0,57	0,11	0,37	0,43	0,31	0,79	0,44	0,93	0,95	0,97	0,81	0,99	0,54	1
FR	0,89	0,04	0,02	0,03	0,63	0,5	0,47	0,46	0,85	0,77	0,66	0,65	0,09	0,66
HU	0,03	0,28	0,03	0,86	0,18	0,89	0,37	0,44	0,26	0,25	0,08	0,06	0,85	0,33
IE	0,82	0,07	0,84	0,95	0,9	0,14	0,94	0,46	0,32	0,37	0,48	0,34	0,12	0,66
Israel	0,93	0,1	0,99	0,91	0,97	0,26	0,16	0,08	0,63	0,43	0,7	0,9	0,72	1
IT	0,95	0,04	0,04	0,55	0,2	0,5	0,08	0,3	0,37	0,37	0,26	0,07	0,05	0,33
Japan	0,99	0,06	1	0,92	0,18	0,16	0,04	0,85	0,43	0,72	0,97	0,99	0,14	0,66
Korea	0,74	0,23	1	0,55	0,42	0,12	0,05	0,92	0,95	0,75	0,68	0,99	0,78	1
LU	0,74	0,07	0	0,01	0,94	0,46	1	0,25	0,35	0,73	0,6	0,12	0,03	0,66
NL	0,77	0,07	0,54	0,35	0,47	0,77	0,81	0,76	0,74	0,58	0,78	0,25	0,66	0,66
NO	0,86	0,06	0,88	0,23	0,87	0,88	0,37	0,5	0,84	0,77	0,55	0,2	0,29	0,33
PL	0,1	0,18	0,07	0,82	0,11	0,54	0,12	0,51	0,25	0,12	0,05	0,01	0,17	0
PT	0,47	0,06	0,97	0,29	0,18	0,29	0,29	0,35	0,7	0,4	0,05	0,14	0,04	0,33
Russia	0	0,76	0,29	0,55	0,44	0,5	0,16	0,13	0,82	0,56	0,05	0,01	0,98	0
SE	0,9	0,08	0,94	0,55	0,7	0,5	0,7	0,43	0,95	0,86	0,91	0,97	0,41	1
SI	0,43	0,13	0,03	0,01	0,28	0,71	0,11	0,49	0,74	0,66	0,08	0,66	0,8	0,66
SK	0,05	0,25	0	0,86	0,29	0,18	0,18	0,33	0,1	0,21	0,05	0,01	0,12	0,33
Taiwan	0,38	0,13	0	0,14	0,35	0,5	0,16	0,76	0,82	0,95	0,29	0,96	0,58	0,66
UK	0,71	0,07	0,73	0,95	0,77	0,57	0,59	0,5	0,46	0,56	0,57	0,22	0,34	0,66
USA	0,33	0,13	0,97	0,98	0,45	0,21	0,11	0,44	0,92	0,13	0,73	0,9	0,51	1

Appendix I: Thresholds used for calibration of variables (Chapter 4)

	health_calib	whohealth_calib	pension_calib	labour_calib	timetax_calib	wtitax_calib	openinvest_cali	educ_calib	gerd_calib	industryherd_calib	triadic_calib	industryherd_calib	personell_calib
n1 (value 0,95)	82	185	65	10	50	0,7	300	550	1	19	90	2	20
n2 (value 0,5)	80	95	62	40	150	0,5	100	500	0,6	10,5	15	1	5
n2 (value 0,05)	75	5	60	50	500	0,3	25	450	0,2	2	0,5	0,5	1

**Direct method of calibration was used.*

Appendix J: A list of frequently used abbreviations

OI – Open innovation
EU – European Union
R&D – research and development
SME – small- and medium-sized enterprises
QCA – qualitative comparative analysis
fsQCA – fuzzy set qualitative comparative analysis
IUS – innovation union scoreboard
IUSSI – innovation union scoreboard summary index
VoC – varieties of capitalism
PLS SEM – partial least squares structural equation model
OECD - The Organisation for Economic Co-operation and Development

Appendix K: An extensive summary of the basic findings in Slovenian language

DALJŠI POVEZETEK KLJUČNIH UGOTOVITEV V SLOVENSKEM JEZIKU

*'**Inovacije ne nastanejo v vakuumu. Nikoli nisi sam. Nihče nima ključa do rešitev sam.'***
Rogier van der Heide, Vodja oblikovanja pri podjetju Philips Lighting

UVOD

Inovacije so stare toliko kot človeštvo. Nekaj globoko 'človeškega' je v tem, da razmišljamo o tem, kako na novo in bolje narediti stvari in jih preskusiti v praksi (Fagerberger et al., 2006, p. 1). Kljub očitni pomembnosti pa inovacije niso bile vedno predmet zanimanja raziskovalcev. Vsaj do 1960-ih let je bilo o inovacijah objavljenih zelo malo raziskovalnih člankov.

Od takrat naprej pa se je raziskovanje inovativnosti močno razširilo, še posebej v družbenih znanostih. Večji interes za raziskovanje inovacij je posledica sprememb v njihovem izvajanju, saj se spremembe v zadnjih nekaj desetletjih bistveno spremenile inovacijske prakse, te pa so vplivale na razvoj novih teorij inovativnosti. Ena od njih je tudi teorija odprtih inovacij. V istoimenski knjigi jo je leta 2003 predstavil prof. Henry Chesbrough (Chesbrough, 2003). Odprti inovacijski sistemi so tisti, kjer podjetja poleg lastnih uporabljajo tudi ideje, ki nastajajo izven okvirjev lastnega podjetja. Prav tako zanje iščejo notranje in zunanje poti do trga. Raziskave in razvoj predstavljajo odprt sistem (H W Chesbrough & Crowther, 2006).

Raziskovalni cilj te disertacije je usmerjen v raziskave odprtih inovacij. Bolj ozko, cilji te disertacije so raziskati poslovno aplikacijo odrtih inovacijskih sistemov v malih in srednje velikih podjetjih (MSP) ter implikacije odprtih inovacijskih sistemov na inovacijske politike.

Pri zasledovanju raziskovalnih ciljev sem si zastavil raziskovalna vprašanja in uporabil raziskovalne metode, ki so predstavljene v tabeli spodaj:

Tabela 28: Pregled raziskovalnih ciljev, raziskovalnih vprašanje ter metod raziskovanja v dizertaciji

	Raziskovalni cilji	**Raziskovalna vprašanja**	**Raz.metode**
Poglavje 2: **Intelektualna struktura odprtih inovacijskih sistemov: kritičen pregled literature in bibliometrična analiza**	1. Predstaviti intelektualno strukturo odprtih inovacijskih sistemov in jih umestiti v raziskovanje inovacij in inovacijskih aktivnosti	1. Kakšna je intelektualna struktura odprtih inovacij in drugih inovacijskih konceptov ? 2. Ali so odprti inovacijski sistemu prispevali k zapolnjevanju vrzeli v našem razumevanju inovacij ?	Kritičen pregled literature Biblio-metrične metode
Poglavje 3 - **Predhodniki dejavnikov omogočanja komercializacije inovacij v visokotehnoloških MSP: Odpiranje črne skrinje odprtih inovacij**	2. Razvoj konceptualnega modela o vplivu uporabe odprtih inovacijskih aktivnosti na visokotehnološke MSP, predvsem na njihove strategije rasti 3. Analiza trendov in uporabe odprtega inoviranja med anketiranimi MSP	3. Kaj so konkretni predhodniki dejavnikov omogočanja komercializacije inovacij v visokotehnoloških MSP ? 4. Kako dve specifični praksi odprtega inoviranja (izmenjava informacij in inovacijsko sodelovanje) vplivata na dejavnike omogočanja komercializacije inovacij z uporabo inovacijskih aktivnosti in inovativnosti ?	Strukturni modeli enačb (SEM)
Poglavje 4 **-** **Nacionalne inovacijske politike v Evropski Uniji: analiza mehkih množic**	4. Prikaz novih metodoloških orodij za raziskovanje inovacijskih politik - konkretno metode mehkih množic v kvantitativni primerjalni analizi na vzorcu nacionalnih inovacijskih politik v EU ;	5. Ali lahko nova metodološka orodja prinesejo nov vpogled v raziskave inovacijskih politik ? 6. Ali povezave med akterji in komercializacija inovacij s podjetništvom predstavljajo obvezni pogoj za inovacijski uspeh ?	fsQCA
Poglavje 5 - **Vladni ukrepi v podpor o odprtim inovacijam: nacionalne politike ki najbolje podpirajo inovacijsko uspešnost držav**	5. Analiza različnih skupin vladnih ukrepov v podporo odprtih inovacijskih sistemov in prikaz različnih kombinacij ukrepov ki najbolj povečajo možnosti za inovacijsko uspešnost držav	7. Kako lahko različne inovacijske politike vplivajo na akterje in nacionalni inovacijski sistem ter vplivajo na reševanje kompleksnih organizacijskih problemov povezanih s transformacijo proti bolj odprtim modelom inoviranja. 8. Ali obstaja razlika med tradicionalnimi, 'ozko' usmerjenimi politikami v podporo inovacijam in drugimi, 'širšimi' politikami, ki lahko vplivajo na lokalno pozicioniranje inovacijskih procesov in razvoja industrijskega znanja ?	Dvo-stopenjska fsQCA

Glavni namen disertacije je raziskovanje odprtih inovacijskih sistemov na treh ozko definiranih področjih: njihovo uporabo v malih in srednje velikih podjetjih, njihove vplive na inovacijske politike ter demonstracija novih raziskovalnih metod za njihovo raziskovanje. Vsako od teh področjih je predmet posebnega poglavja, četrto ključno vprašanje pa vsebuje pregled trenutnega obsega znanja o odprtih inovacijskih sistemih.

INTELEKTUALNA STRUKTURA ZNANSTVENEGA PODORČJA ODPRTIH INOVACIJSKIH SISTEMOV: KRITIČNI PREGLED LITERATURE

Odprti inovacijski sistemi so znanstven koncept, ki ge je prvi predstavil Henry Chesbrough leta 2003 v istoimenski knjigi. Odprto inoviranje predpostavlja, da podjetja uporabljajo ideje iz okolja poleg lastnih idej ter da iščejo tako notranje kot zunanje poti za njihovo trženje. Raziskave in razvoj predstavljajo odprti sistem (H W Chesbrough & Crowther, 2006). Čeprav prof. Chesbrough trdi, da sistemi odprtega predstavljajo paradigmo pri raziskovanju inovativnosti, pa pregled literature hitro pokaže, da je bil prehod od 'zaprtih' inovacijskih sistemov v odprte bistveno bolj evolucijski. Koncept odprtega inoviranja je bil deležen tudi več različnih kritik, od njegove nejasnosti ki posledično preprečuje generalizacijo do ugibanj, da bo 'odprto' inoviranje z nadaljevanjem sprememb pri izvajanju inovacijskih aktivnosti v podjetjih kmalu postalo 'standardno' inoviranje. Celo poimenovanje koncept je bilo kritizirano, saj naj bi omejevalo nadaljnje raziskave inovativnosti in deloval kot komunikacijska prepreka.

Na ta vprašanja sem v disertaciji poskušal odgovoriti s pregledom obstoječe literature in bibliometrično analizo odprtega inoviranja. Rezultati so pokazali, da je znanstvena pozornost inoviranju relativno nov fenomen in da pred šestdesetimi leti 20. stoletja na temo inovativnosti ni bilo objavljenih prav veliko znanstvenih prispevkov, da pa njihovo število močno narašča po tem. Koncept odprtega inoviranja je v prvem desetletju 21. Stoletja deležen precej pozornosti, saj znanstveni prispevki iz tega področja hitro naraščajo in v letu 2013 predstavljajo že 8 % vseh znanstvenih prispevkov s področja inovativnosti in inovacij. Bibliometrična analiza znanstvenih prispevkov tudi pokaže, da se znanstveni prispevki s področja odprtih inovacij najbolj osredotočajo na upravljanje raziskave in razvoja v podjetjih (kljub temu da je koncept uporaben tudi na drugih področjih). Analiza pa tudi pokaže, da so avtorji o odprtem inoviranju govorili že pred letom 2003. Vsi ključni znanstveni prispevki na področju odprtega inoviranja se sklicujejo tudi na raziskovalne temelje, ki so jih postavili drugi avtorji s področja inovativnosti, predvsem v osemdesetih in devetdesetih letih prejšnjega stoletja. Koncepti absorbcijske sposobnosti podjetij, komplementarnih sredstev, inovacij ki temelji na inputih uporabnikov in predvsem koncept inovacijskih sistemov (ki vključujejo kupce, dobavitelje, konkurente, univerze in druge organizacije) so koncepti, ki so ključnega pomena za razumevanje doprinosov, ki jih je prinesel koncept odprtega inoviranja. Prehod na odprte inovacijske sisteme je torej precej manj revolucionaren na znanstvenem področju (analiza pokaže da je bolj revolucionaren za

podjetja, ki se soočajo s spremembami v okolju, na katere se morajo odzivati z odpiranjem, kar pa jim teoretično utemelji koncept odprtega inoviranja).

Te spremembe v okolju pa so vplivale na raziskovanje inovativnosti z nastankom več novih konceptov, ne samo odprtega inovacijskega koncepta. Predvsem koncept uporabniškega inoviranja, s katerim je leta Von Hippel (2005) nadgradil svoje prejšnje raziskave s področja ključnih uporabnikov, predstavlja zelo podoben in pogosto uporabljan znanstven pogled na raziskave na področju odprto-kodnega programiranja in podobnih inovacijskih aktivnosti. Vendar pa sta tako uporabniško inoviranje kot odprto inoviranje dva ločena in pogosto celo nasprotujoča si koncepta, vendar pa lahko oba prispevata k razumevanju inovativnosti. Koncept odprtih inovacijskih sistemov je tako prispeval novo znanje na področju teorije podjetja, k razvoju novih inovacijskih politik, grozdov ter tudi na drugih področjih.

S temi ugotovitvami lahko ugotovim, da je koncept odprtega inoviranja samo eden od več komplementarnih konceptov, ki prispevajo k razumevanju inovativnosti. Nerealno je pričakovati, da bo en sam koncept (na primer odprto inoviranje) postal edini koncept ki bo pravilno opisal tako kompleksno področje kot je inovativnost. Istočasno pa je tudi jasno, da odprto inoviranje prinaša nove poglede na inovativnost, ki so bistveno različni od drugih konceptov, celo zelo sorodnih kot je koncept uporabniškega inoviranja. Tako je nerealno trditi, da lahko (kateri koli) posamični koncept predpostavlja oviro pri nadaljnjem raziskovanju inovativnosti, po mojem prepričanju napačno. Bolj relevantno in tudi pomembno bi bilo jasno definirati različne koncepte in razlike med njimi. Mejni pogoji in kontekstualne odvisnosti za vsak znanstven koncept inovativnosti bi pripomogle k razumevanju, kdaj določen koncept ni več najbolj primeren za preučevanje določenega fenomena.

Nenazadnje, moja analiza tudi jasno pokaže, da odprta inovativnost ne predstavlja nove paradigme pri raziskovanju inovativnosti. Kljub temu pa je koncept vseeno uporaben in koristen, saj pomaga tako pri teoretičnem razumevanju inovativnosti kot tudi pri implementaciji inovacijskih aktivnosti v praksi.

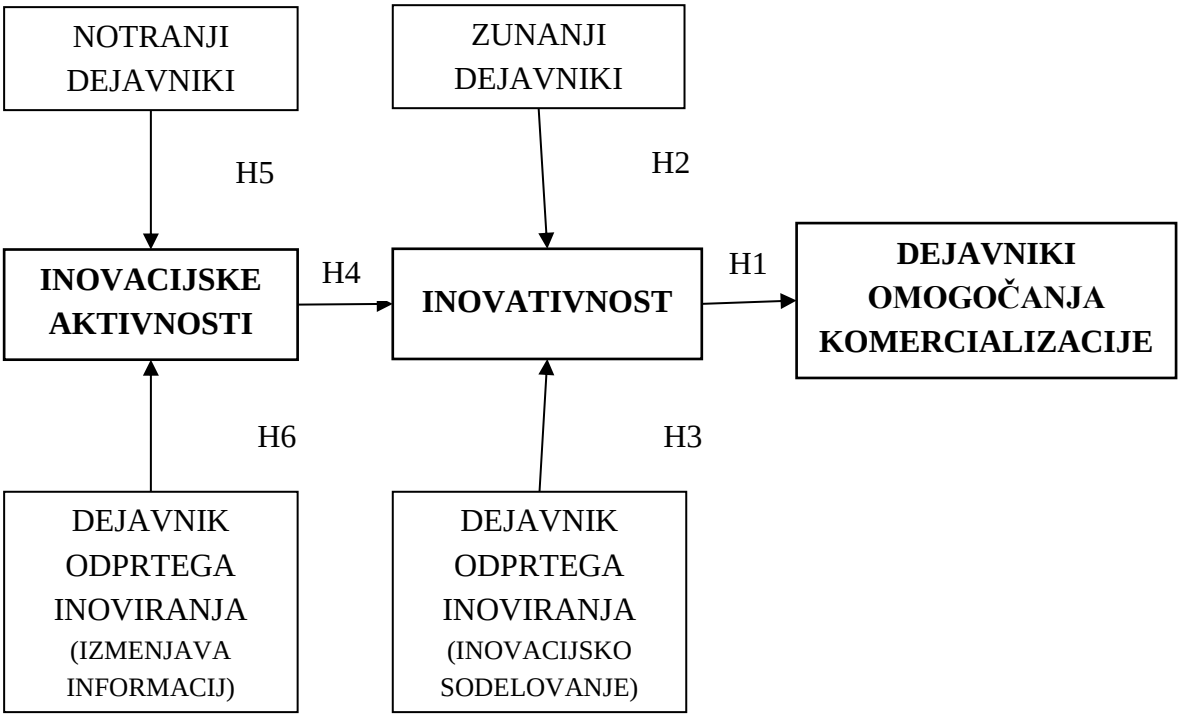
DEJAVNIKI OMOGOČANJA KOMERCIALIZACIJE V VISOKOTEHNOLOŠKIH MALIH IN SREDNJE VELIKIH PODJETIJ: ODPIRANJE ČRNE SKRINJE PRAKS ODPRTEGA INOVIRANJA

V tem poglavju sem na podlagi zbranih podatkov o uporabljenih praksah odprtega inoviranja med 105 visokotehnološkimi malimi in srednje velikimi podjetij oblikoval strukturni model enačb. Zaradi relativno majhnega vzorca (ki je posledica majhne populacije visokotehnoloških podjetij v Sloveniji) in zaradi jasnih metodoloških prednosti sem za testiranje strukturnega modela enačb uporabil metodo delnih najmanjših kvadratov.

Glavni prispevek tega poglavja je viden v jasno pokazanem vplivu dveh konkretnih praks odprtega inoviranja – izmenjavanje informacij ter inovacijsko sodelovanje – na omogočanje komercializacije inovacij. To poteka z vplivom na njihove inovacijske

aktivnosti ter z vplivom na inovativnost. Poleg teh dejavnikov na inovacijske aktivnosti vplivajo interni (organizacijski) dejavniki v visokotehnoloških podjetjih, na inovativnost pa tudi drugi dodatni dejavniki.

Slika 12: Shema strukturnega modela enačb



Rezultati pokažejo močno podporo vplivom notranjih in zunanjih dejavnikov na inovacijske aktivnosti oziroma inovativnost. Prav tako je viden močan vpliv inovacijskega sodelovanja na inovativnost ter vpliv inovativnosti na dejavnike omogočanja komercializacije. Vpliv odprto-inovacijske prakse izmenjave informacij pa ni statistično značilen, saj obstaja 5,7 % možnost napake. Zaradi majhne velikosti vzorca bi sicer tudi takšen vpliv lahko potrdili.

Tabela 29: Rezultati strukturnega modela enačb

Pot (hipoteza)	Koef-icient poti	R^2	t-vrednost (temelji na 'bootstrapping postopku)	Df**	p vrednost
Notranji dejavniki → inovacijske aktivnosti	0.82	**0.17**	2.97	499	0.003
Dejavnik odprtega inoviranja (izmenjava informacij) → inovacijske aktivnosti	0.32		1.91	499	0.057
Zunanji dejavniki → inovativnost	0.11	**0.33**	2.80	499	0.005
Inovacijske aktivnosti → inovativnost	0.21		4.33	499	0.000
Dejavnik odprtega inoviranja (inovacijsko sodelovanje) → inovativnost	0.17		2.31	499	0.021
Inovativnost → dejavniki omogočanja komercializacije	0.68	**0.12**	4.43	499	0.000

Vir: Anketa visokotehnoloških malih in srednje velikih podjetij 2012 (n=105 podjetij).
Opombe: *Raven značilnosti koeficientov poti temelji na 'bootstrapping' postopku (s 500 vzorci). **Df=Stopinje prostosti. Ugotovljene kot po postopku vzorcev 'bootstrapping-a' minus 1 (Sosik et al., 2009).

Kljub relativno nizki napovedne uspešnosti modela, ki pojasni 12 % variabilnosti odvisnega reflektivnega latentnega konstrukta (dejavnikom omogočanja komercializacije), pa je model robusten. Model smo testirali glede na panogo (proizvodne ali storitvene visokotehnološke dejavnosti) in glede na velikost (mala ali srednje velika podjetja) ter ugotovili, da se nobena kontrolna spremenljivka nima značilnega vpliva na dejavnike omogočanja komercializacije. Nizka napovedna uspešnost je tudi povsem primerljiva s tradicionalnimi ekonometričnimi študijami in odraža splošno kompleksno naravo dejavnikov omogočanja komercializacije v visokotehnoloških podjetjih.
Teoretično, rezultati potrjujejo predpostavke teorije podjetja, ki temelji na pomembni vlogi sredstev, saj so mala in srednja podjetja pri zasledovanju rasti najbolj omejena s pomanjkanjem sredstev. Dodatno ugotavljam, da visokotehnološka mala in srednje velika podjetja, ki se odločijo za široko razvejano inovacijsko sodelovanje z zunanjimi partnerji, postanejo bolj inovativna, to pa jim omogoči boljšo komercializacijo inovacij. To je skladno z drugimi teoretičnimi koncepti, ki poudarjajo pomen sodelovanja.
To pa vpliva tudi na inovacijske politike. Če želijo pomagati razviti visokotehnološka podjetja bi se morali določevalci inovacijskih politik osredotočiti na pospeševanje

povezovanja med podjetji in na skupno inovacijsko sodelovanje, seveda z mislijo na kasnejšo komercializacijo inovacij.
V tem poglavju sem torej potrdil, da komercializacija inovacij ni samo direktno povezana z odprtim inoviranjem, ampak sem orisal tudi jasen mehanizem, kako to poteka. Za podjetja pa je ugotovitev jasna – večja odprtost ne vpliva samo na povečanje inovativnosti, ampak tudi na bolj uspešno komercializacijo njihovih rezultatov.

NACIONALNE INOVACIJSKE POLITIKE V EVROPSKI UNIJO: ANALIZA MEHKIH MNOŽIC

V tem poglavju demonstriram uporabo novih raziskovalnih metod za preučevanje nacionalnih inovacijskih politik. Le-te v današnjem svetu predstavljajo eno najpomembnejših razvojnih politik, ki jih imajo na razpolago vlade. Z njimi lahko pojasnimo izjemen gospodarski napredek določenih gospodarstev, ki jih pogosto opisujemo kot gospodarski čudež.
Ena ključnih ugotovitev koncepta odprtega inoviranja, kot sem ga predstavil v prejšnjih poglavjih, je pomembnost povezav med različnimi akterji ter ključno vlogo podjetništva pri komercializaciji rezultatov inovacij. Zato sem v analizo nacionalnih inovacijskih politik vključil tudi poseben dejavnik, ki meri rezultate nacionalnih politik na področju povezav in inovativnosti. Za ta dejavnik sem oblikoval tudi formalno hipotezo, da je ta dejavnik potrebni pogoj za vsako inovacijsko uspešno državo.
To hipotezo testiram z uporabo nove raziskovalne metode. Ne-standardne raziskovalne metode lahko pripeljejo do drugačnih priporočil za oblikovanje politik. To demonstriram z uporabo kvantitativne primerjalne analize mehkih množic (fsQCA) na podatkih o inovacijskih politikah držav članic Evropske Unije. V poglavju pokažem, da je uporaba korelacijskih statističnih metod za analizo nacionalnih inovacijskih politik neprimerna zaradi njihove vzročne kompleksnosti, ki jo standardne statistične metode ne morejo upoštevati. Vzročna kompleksnost je prikazana na primeru posebne pomembnosti inovacijskih politik na področju povezav in podjetništva. Za države članice Evropske Unije uporabim podatke, ki se letno zbirajo v okviru iniciative Innovation Union Scoreboard (semafor Unije Inovacij - IUS). V analizo sem vključil vse dejavnike, ki jih pokriva iniciativa, vključno z dejavnikom Povezave in podjetništvo. Vendar pa sem za razliko od metodologije IUS, ki na osnovi teh dejavnikov oblikuje kompozitni indeks, sam uporabil metodo kvantitativne primerjalne analize mehkih množic (fsQCA).

Tabela 30: Rezultati QCA analize

Rešitev	**E*D*C**	**+**	**E*D*A**	**+**	**F*E*C*B*A**
Pokrivanje posameznih držav	Estonija		Irska, Avstrija, Slovenija		Francija, Nizozemska
Konsistentnost	0.96		1.00		1.00
Grobo pokrivanje	0.58		0.62		0.55
Edinstveno pokrivanje	0.07		0.11		0.07
Konsistentnost rešitve			0.971		
Pokrivanje rešitve			0.753		

Notes: * *A= hr_c= Človeški viri*
B= rs_c= Odprti, odlični in privlačni raziskovalni sistemi
C= fs_c= Finance in podpora
D= fi_c= Investicije podjetij
E= la_c = Povezave in podjetništvo = potrebni pogoj (prisoten v vseh zadostnih pogojih)
F= ia_c = Sredstva intelektualne lastnine
*** Finska, Švedska, Švica, Belgija, Danska, Nemčija, Luxembourg in UK so bili pokriti v z več kot eno kombinacijo zadostnih pogojev.*

Z uporabo fsQCA metode pokažem, da ta dejavnik predstavlja potrebni pogoj za inovacijsko uspešnost. S tem potrdim pomembnost in uporabnost koncepta odprtega inoviranja za inovacijske politike. Poleg tega rezultati tudi pokažejo tri kombinacije zadostnih pogojev, ki prav tako vodijo do inovacijske uspešnosti. Vsi rezultati so robustni in izpolnjujejo vse kriterije kvalitete, saj dobro pojasnijo inovacijsko uspešnost velike večine držav EU. Kljub temu posebej izpostavim tudi Estonijo in Norveško, ki bi lahko bili dobri tarči za nadaljnje raziskave oziroma tarči za poglobljeno študijo primerov. Raziskava potrdi vzorčno kompleksnost inovacijskih politik in s tem osnovno predpostavko, da so za njihovo raziskovanje potrebne drugačne raziskovalne metode. Prav tako pa potrdi pomembnost koncepta odprtega inoviranja, saj pokaže, da pomanjkanje povezovanja in mreženja preko meja posameznih organizacij predstavlja t.i. sistemsko vrzel, prav tako kot tudi 'zaklenjene' povezave s specifičnimi inovacijskimi partnerji, viri idej in informacij ali pa prevelika zaprtost procesov organizacijskega učenja. Sistemsko vrzel je potrebno obravnavati podobno kot tržne vrzeli – z javnimi politikami za njihovo preseganje. Ključnega pomena za inovacijsko uspešnost so torej politike na za podporo povezavam in podjetništvu (ter drugim oblikam komercializacije) – torej aktivnostim odprtega inoviranja.

KAKO KONCEPT ODPRTIH INOVACIJ VPLIVA NA INOVACIJSKE POLITIKE: NACIONALNA MEŠANICA INOVACIJSKIH POLITIK, KI VODI DO INOVACIJSKEGA USPEHA

Raziskave inovacijskih politik sem nadaljeval in razširil v četrtem poglavju. Pregled literature je pokazal potrebo po raziskovanju širših družbenih sprememb v luči prehoda organizacije nacionalnih inovacijskih politik in institucij zaradi sprememb v inovacijskih aktivnostih, kot jih opisuje koncept odprtega inoviranja.

Spremembe v globalnem inovacijskem okolju, vključno s tretjo industrijsko revolucijo, globalizacijo inovacijskih aktivnosti ter nastopom ekonomske krize so povečale interes za raziskave novih inovacijskih konceptov kot je na primer odprto inoviranje. Ti koncepti imajo potencial, da lahko pomagajo deležnikom inovacijskega sistema premagati težave povezane z ekonomsko krizo in da lahko celo pripomorejo k nastanku novih oblik razvoja. Vendar pa ostaja vprašanje, kaj lahko določevalci politik naredijo, da izboljšajo in olajšajo prehod v nove organizacijske oblike ter kako lahko najbolje izkoristijo družbene koristi, ki jih inovacije prinesejo. Teorija potrjuje, da je tukaj vloga javnih politik potrebna in pomembna, saj zgolj tržna koordinacija in alokacija sredstev ne pripelje do družbeno optimalnega investiranja v inovacij (nastanejo t.i. tržne vrzeli). Poleg tega raziskovalci ugotavljajo, da je za promocijo razvoja in širitve novih tehnologij morda še pomembnejša sistemska vrzel. Ker so inovacije posledica kompleksnih evolucijskih procesov, ki se dogajajo v sistemu s številnimi socio-ekonomskimi agenti. Njihovo obnašanje in povezovanje pa ni odvisno zgolj od tržnih sil ampak tudi od drugih ne-tržnih dejavnikov in institucij. Povezave med temi agenti služijo kot kanali za širitev znanja in za njegovo kombiniranje, zato pomanjkanje povezav predstavlja sistemsko vrzel, ki jo je prav tako potrebno premagati z intervencijo in javnimi politikami.

Ostaja pa vprašanje, kakšne javne politike so najbolj primerne in učinkovite za takšno intervencijo. Kar nekaj raziskav je že poskušalo analizirati vplive novih inovacijskih konceptov (in tudi konkretno koncepta odprtega inoviranja) na inovacijske politike. Ugotovile so, da so še vedno najpomembnejše nacionalne inovacijske politike, ki pa jih je vedno bolj pomembno umeščati glede na njihov vpliv na globalne inovacijske ekosisteme in inovacijske mreže. Takšne globalne inovacijske mreže povezujejo raziskovalce, javne in zasebne raziskovalne institucije, ter druga podjetja (tako veliko kot SME) v različnih državah. Znotraj takšnih mrež se oblikujejo mednarodna središča, ki povezujejo mednarodne in nacionalne inovacijske sisteme. Lokacije teh središč so odvisne od privlačnosti posamezne lokacije za inovacijske aktivnosti. Pogosto celo konkurenčni ekosistemi pozicionirajo njihove raziskave, razvoj in inovacijske oddelke v istih lokacijah, da lahko izkoriščajo prednosti ki jih nudijo politike ter ekonomije obsega. Zato morajo biti nacionalne inovacijske politike umeščene v mednarodni kontekst. Poleg tega so te politike lahko bistveno bolj različne kot se običajno predpostavlja, saj obsegajo vse javne politike, ki lahko vplivajo na primernost lokacije, da postane mednarodno inovacijsko središče.

V tem poglavju sem se osredotočil na različne oblike javnih politik, ki vplivajo na udeležence nacionalnih inovacijskih sistemov. Različne konfiguracije teh politik sem

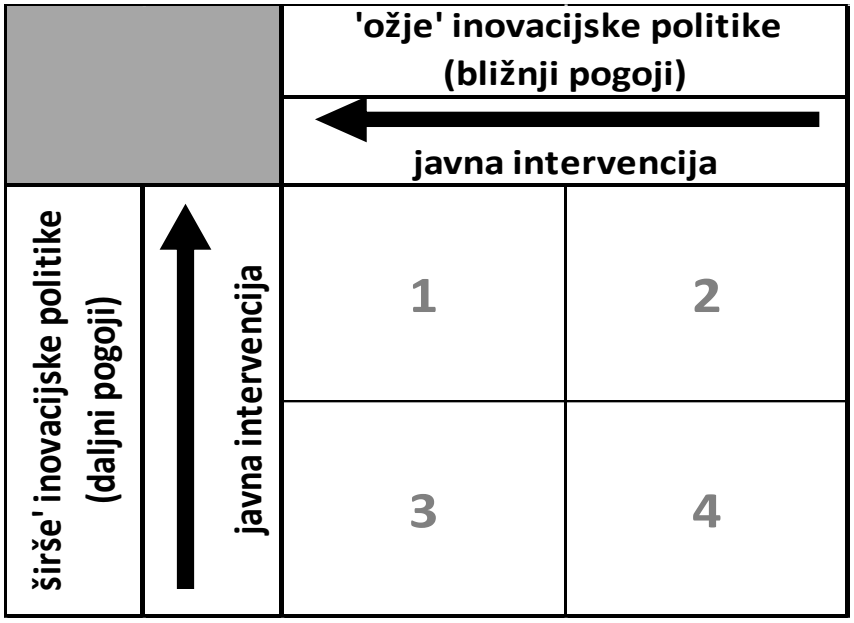
ponovno analiziral z uporabo kvantitativne primerjalne analize (fsQCA), vendar tokrat z uporabo posebne oblike te analize, ki omogoča uporabo dveh korakov. To mi je omogočilo ločeno analizo 'bližnjih' dejavnikov ozko specializiranih inovacijskih politik ter 'širših' dejavnikov politik, ki vplivajo na splošno inovacijsko in institucionalno okolje, ki lahko zaradi njih postane bolj privlačno za izvedbo inovacijskih aktivnosti.

Na podlagi zgornje analize sem pripravil tri hipoteze o potrebnih in/ali zadostnih pogojih za inovacijsko uspešnost držav: da imajo uspešne 'ozko' specializirane inovacijske politike, da imajo primerne 'širše' politike ki ustvarijo okolje ki je privlačno za inovacijske središča ter hipotezo o tem, ali so katere koli politike ('ožje' ali 'širše') potrebne ali zadostne za inovacijsko uspešnost.

Za testiranje hipotez sem zbral bazo podatkov o pet skupinah 'ožjih' inovacijskih politik ter šest skupinah 'širših' politik za podporo inovativnosti. Vse testirane politike temeljijo na teoretičnih podlagah kot so bile utemeljene na OECD ali pa v 'varieties-of-capitalism' literaturi. Kot kriterij inovacijske uspešnosti sem uporabil IUS indeks, ki sicer ni popolno merilo za merjenje inovacijske uspešnosti, je pa za namen te raziskave vseeno uporabno. 'Ožje' in 'širše' politike se lahko tudi lepo razdelijo med bližnje dejavnike vpliva na inovacijsko uspešnost ter na bolj oddaljene dejavnike vpliva. To nam omogoča uporabo dvo-stopenjske fsQCA metode, ki je namenjena ravno testiranju takšnih konfiguracij dejavnikov.

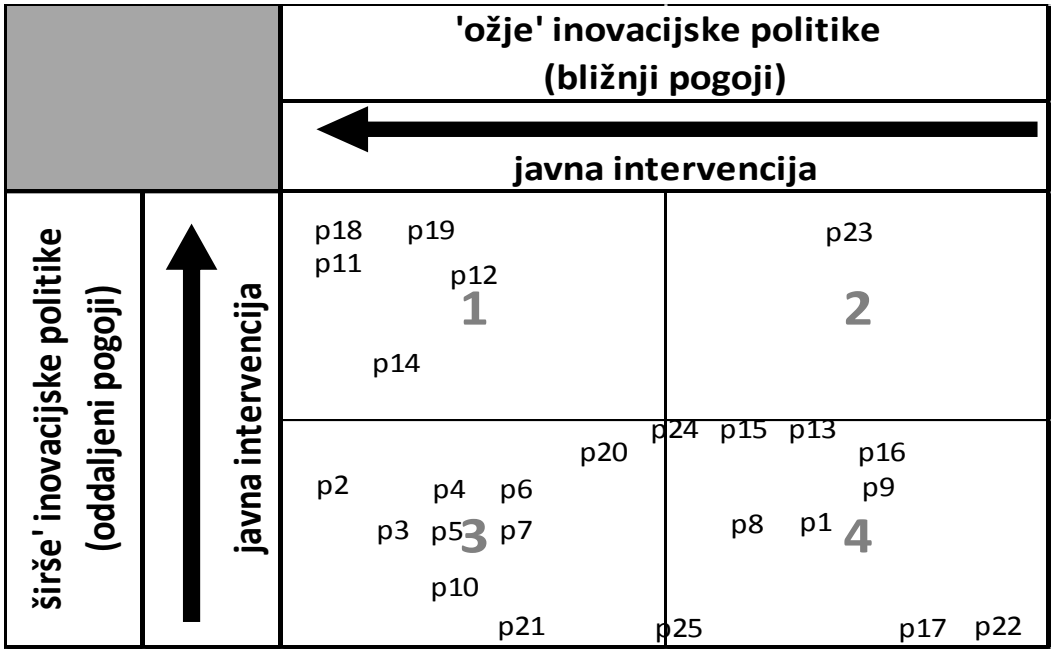
Za testiranje hipotez sem razvil posebno orodje – matriko inovacijskih politik. Kot je razvidno iz slike spodaj imajo določene države razvite tako 'ožje' kot 'širše' politike v podporo inovativnostim in bodo zato uvrščene v prvi kvadrant matrike. Države, ki imajo zgolj 'ožje' politike, bodo uvrščene v tretji kvadrant. Če bo analiza pokazala države v tem kvadrantu bom lahko zavrnili hipotezo, da so 'širše' politike v podporo inovativnosti potrebni pogoj za inovacijsko uspešnost. Podobno velja za države v drugem kvadrantu, saj mi bo njihova prisotnost tam omogočila, da zavrnem hipotezo o 'ožjih' politikah kot potrebnem pogoju za inovacijski uspeh. In nazadnje, prisotnost držav v četrtem kvadrantu bi zavrnila hipotezo, da je prisotnost 'ožjih' ali 'širših' politik potreben pogoj za inovacijsko uspešnost.

Slika 13: Matrika inovacijskih politik



Po implementaciji dvostopenjskega QCA postopka sem dobil 25 rešitvenih poti (vsak takšna pot lahko predstavlja eno ali več inovacijsko uspešnih držav z isto konfiguracijo politik). Ko sem te poti razvrstil v matriko rešitev se izkaže, da je najmanj ena pot (in s tem država) prisotna v vsake kvadrantu matrike. To pomeni, da lahko zavrnem vse tri hipoteze. Niti 'ožje' niti ' širše' politike niso potrebni ali zadostni pogoj za inovacijsko uspešnost držav.

Slika 14: Matrika inovacijskih politik z vrisanimi rešitvenimi potmi



Poleg tega formalnega sklepa pa lahko potegnem še nekaj dodatnih opazovanj. Kljub formalni zavrnitvi hipotez je jasno vidno, da vsaj neka oblika javne intervencije bistveno poveča možnosti za inovacijsko uspešnost (čeprav formalno ni nujna). Rešitve tudi pokažejo nekaj zanimivih primerov, ki jih bi bilo smiselno poglobljeno raziskati. Tipičen primer je Irska, ki je najbolj izpostavljen primer države brez uspešnih 'ožjih' ali 'širših' politik, pa je vseeno inovacijsko uspešna. Zadnja ugotovitev pa je, da je za določevalce politik smiselno, da osredotočajo sredstva na samo nekaj inovacijskih politik ne poskušajo razviti vseh politik – predvsem to velja za 'ožje' inovacijske politike. Specializacija na določene 'ožje' inovacijske politike je možna (kar kaže veliko različnih rešitvenih poti in primerov držav, ki so jo izvedle) in lahko prihrani veliko javnih sredstev. Pri 'širših' politikah pa se je pokazalo, da določeni dejavniki (na primer davčna fleksibilnost) nimajo vpliva na inovacijsko uspešnost, na drugi strani pa so drugi dejavniki posebej pomembni za skoraj vse primere – na primer ureditev trga dela in socialnih sistemov. To se sklada z 'varieties-of-capitalism' pristopom, ki pokaže, da so države lahko uspešne v inoviranju tako v liberalnih tržnih ekonomijah kot v bolj koordiniranih ekonomijah. Posebno pozornost tukaj posvečam Skandinavskim državam, ki so našle posebne obliko kombinacij politik, ki so istočasno inovacijsko uspešne in imajo razvito omogočajočo socialno državo.

SKUPNA DISKUSIJA PRISPEVKOV IN ZAKLJUČEK

Eden od najpomembnejših prispevkov doktorske disertacije za znanstveno področje inovativnosti je pregled prispevkov koncepta odprtega inoviranja k splošnemu razumevanju inovacij in inovativnosti. Rezultat raziskovanja tega širšega raziskovalnega področja je prepoznavanje ožjih raziskovalnih področij, ki jih odprti inovacijski sistemi še niso dovolj dobro raziskali. Ta področja so bila ožji predmet mojih doktorskih raziskav:

- razumevanje praks odprtega inoviranja v malih in srednje velikih podjetjih
- implikacije odprtega inoviranja na inovacijske politike
- empirična raziskava o praksah odprtega inoviranja v visokotehnoloških malih in srednje velikih podjetjih
- nove raziskovalne metode za raziskovanje inovacijskih politik.

Prispevki te doktorske disertacije so predstavljeni v sliki spodaj.

Slika 15: Shema prispevkov disertacije k konceptu odprtega inoviranja

Z raziskovanjem področja odprtih inovacij in ugotovitvami svojih raziskav sem s svojim doktorskim delom prispeval k razumevanju področja inovativnosti. Prispevki se nanašajo na štiri področja:

1. Prispevki k teoriji inovativnosti
2. Metodološki prispevki
3. Prispevki za vodenje inovativnih organizacij
4. Prispevki za določevalce javnih politik na področju inovativnosti

Ključne ugotovitve disertacije so naslednje:

- koncept odprtih inovacij je poseben koncept inovativnosti, ki ima vlogo v celotnem področju raziskovanja inovativnosti. Koncept ne predstavlja komunikacijske ovire niti ne ovira nadaljnjega raziskovalnega dela. Prav tako pa koncept odprtega inoviranja ne predstavlja nove paradigme v raziskovanju inovativnosti.
- Za raziskovanje odprtih inovacijskih praks v malih in srednje velikih podjetjih sem oblikoval model dejavnikov vplivanja na komercializacijo inovacij v visokotehnoloških podjetjih. Z modelom lahko potrdim močan in pozitiven vpliv med inovativnostjo in dejavniki komercializacije inovacij, prav tako pa pokažem da je inovacijsko sodelovanje

(kot ga opisuje koncept odprtih inovacij) pomemben dejavnik, ki vpliva na inovativnost teh podjetij.

- Pri raziskovanju inovacijskih politik v EU sem pokazal, da imajo inovacijske politike lastnosti vzročne kompleksnosti in da zato tradicionalne statistične metode niso najbolj primerna raziskovalna metoda za njihovo analizo. To sem demonstriral z uporabo primerjalne kvantitativne analize mehkih množic, ki so lahko potrdile da dejavnik inovacijskih politik, ki vplivajo na povezovanje in komercializacijo predstavljajo potreben pogoj za inovacijsko uspešnost držav.
- Nazadnje pa sem z analizo 'ožjih' in 'širših' politik ki vplivajo na inovativnost pokazal, da večina rešitvenih poti (in z njimi večina inovacijsko uspešnih držav) uporablja inovacijske politike. Države, ki želijo postati inovacijsko uspešne, naj zato vsekakor razmislijo tako o oblikovanju primernega širšega inovacijskega okolja, kot o ozko ciljanih politikah v podporo inovativnostih. Te pa so lahko specializirane, saj običajno države ne podpirajo vseh dejavnikov inovativnosti ampak se specializirajo samo na nekaj področij. Kljub temu sem formalno moral zavrniti nujnost inovacijskih politik za inovacijsko uspešnost, saj so določene poti pokazale, da je inovacijska uspešnost možna tudi brez uspešnih politik. Takšne države je gotovo potrebno še bolje raziskati v nadaljnjih raziskavah.

Kot vsaka doktorska disertacija je tudi moja šele začetek raziskovalnega dela, ki s svojimi ugotovitvami, ki mu bo sledili nadaljnje raziskovalno delo. Poleg že omenjenih študij primerov inovacijsko uspešnih držav brez jasnih javnih politik v spodnji tabeli navajam še nekaj dodatnih področij za nadaljnje raziskave:

Tabela 31: Področja za dodatne raziskave

Raziskave odprtih inovacijskih sistemov v malih in srednje velikih podjetjih
Raziskovanje razlik v uporabi aktivnosti odprtih inovacijskih sistemov med malimi in srednje velikimi podjetji (MSP) v različnih državah in v različnih nacionalnih poslovnih sistemih
Raziskovanje različnih učinkov drugih aktivnosti odprtih inovacijskih sistemov, kot na primer licenciranja, 'spin-off' podjetij ter skupnih vlaganj, kot tudi kupovanje intelektualne lastnine v okviru komercializacijskih aktivnosti v visokotehnoloških MSP
Nadalje opazovanje podjetij, ki so bila del vzorca raziskave visokotehnoloških MSP več zaporednih let. Dodajanje dodatnih časovnih opazovanj o njihovih aktivnostih odprtega inoviranja in rezultatov teh aktivnosti
Raziskovanje malih mednarodnih podjetij in manjših globalnih podjetij, ki so postala mogoča zaradi globalizacije inovacij in nastajajočih inovacijskih ekosistemov. Izvedba več poglobljenih študij primerov ali akcijskega raziskovanja bi bila lahko zanimiva metoda njihovega raziskovanja
Raziskave povezane z inovacijskimi politikami
Razvoj načina za direktno merjenje uspešnosti inovacijskih politik in posameznih ukrepov namesto za indirektno merjenje z uporabo obstoječih indikatorjev inovativnosti
Bolj poglobljeno raziskovanje posameznih inovacijskih politik, morda z uporabo evalvacijskih metod
V tej disertaciji je bilo identificiranih več držav za nadaljnje raziskave v obliki poglobljenih študij primerov
Časovna analiza javnih politik
Raziskave inovacijskih politik, ki vplivajo na razvoj štartnih (startup) podjetij
Razširitev raziskav na področje institucionalnih struktur in okvirnih pogojev za uspešne (odprte) inovacijske politike