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School of Economics and Business Administration, University of Tartu, Estonia

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INTRODUCTION

This thesis is based on three original papers listed below, which will hereinafter be referred to as Study 1, Study 2 and Study 3:

Study 1. **Rõigas, K**., Mohnen, P., Varblane, U. (2018). Which Firms use Universities as Cooperation Partners? – The Comparative View in Europe. *International Journal of Technology Management*, 76 (1–2), pp. 32–57.

Study 2. Seppo, M., **Rõigas, K.**, Varblane, U. (2014). Governmental Support Measures for University Industry Cooperation – Comparative View in Europe. *Journal of the Knowledge Economy*, 5 (2), pp. 388–408.

Study 3. Kozlinska, I., Mets, T., **Rõigas, K.** (2017). Perceived Learning Outcomes of Experiential Entrepreneurship Education: the Case of Latvian Business Schools. In: Susana C. Santos, António Caetano, Craig Mitchell, Hans Landström and Alain Fayolle (Ed.). *The Emergence of Entrepreneurial Behaviour: Intention, Education and Orientation*, pp. 165–195. Cheltenham, UK, and Northampton, MA, USA: Edward Elgar Publishing. (European Research in Entrepreneurship; 7).

Motivation for the research

Cooperation between the university and industry has gained increasing interest in the light of knowledge being an important source for development, from the perspective of both scientists and policy makers. In the globalisation era, there is a growing need for external knowledge for a firm to be successful in innovation activities (von Hippel 1988, Chesbrough 2003, Chesbrough 2006) and to sustain its competitive advantage (Teece et al. 1997). External knowledge can be gained from several sources, including customers, suppliers, competitors, both private and public research institutions (Laursen and Salter 2006, Leiponen and Helfat 2010, Köhler et al. 2012, Laursen 2012).

As stated in Klevorick et al. (1995), scientific knowledge can be seen as one of the most important sources for technological development. At the same time, also education is considered to be a driver for innovation through creating human capital (Nelson and Phelps 1966, Smith et al. 2005). Therefore, the university is a valuable source of knowledge both in terms of research and education. Learning is considered to play a central part in recent models of innovation process (Caraça et al. 2008). With the second academic revolution, the third mission of universities emerged, which can be described as the engagement to communities and the "… translation of research findings into intellectual property, a marketable commodity, and economic development" (Etzokwitz

and Webster 1998: 21). These changes make universities a valuable source of knowledge for innovation.

Via the continuous research on university-industry cooperation, understanding this cooperation has been improving over time (Etzkowitz 1993, Etzkowitz and Leydesdorff 1995, Etzkowitz and Leydesdorff 2000, Etzkowitz 2003, Carayannis and Campbell 2009). The knowledge triangle, a recent concept reflecting all three missions of universities, explains the significance of both research and education for innovation (Sjoer et al. 2016, Unger and Polt 2017). While the innovation system focuses on the actors and their interrelations (Freeman 1987, Lundvall 1992), the concept of the knowledge triangle emphasises the activity-perspective inside the innovation system. The performance of an innovating firm, which is in the centre of the innovation system depends on one hand on the capabilities of entrepreneurs and skilled workforce, which in turn is related to the education and research system (Lundvall 1992, Kuhlmann and Arnold 2001, Tether and Tajar 2008). On the other hand, performance is dependent on the background settings (context) and how it supports the development and performance of the firm (Polt et al. 2001, Kuhlmann and Arnold 2001).

The importance of the university as a knowledge source for innovation is also emphasised by the European Commission in several studies and reports (see for example, the European Commission 2006, 2009, Healy et al. 2012, Allinson et al. 2013, 2015) and in the strategy of Europe 2020 that advises the member states to strengthen university-industry cooperation (European Commission 2010).

There is a growing body of literature on the benefits (in terms of higher productivity, faster growth, increase in innovative activities) of using universities as one of the knowledge sources, including papers explaining the complementarities between using knowledge from universities in addition to other knowledge sources; see, for example Cassiman and Veugelers (2006), Belderbos et al. (2006), Love and Roper (2009), Huang and Yu (2011), Roper and Arvanitis (2012), Temel et al. (2013), Fındık and Beyhan (2015).

However, studies on university-industry cooperation reveal the cooperation to be at a low level. That holds both for the studies that cover the viewpoints of the university (see, for example Davey et al. 2011, 2018, Kaymaz and Eryiğit 2011, Chandrasekaran et al. 2015) and the studies that discuss the viewpoints of industry representatives, for example different waves of the Community Innovation Survey (hereinafter the CIS).

The current situation, where university-industry cooperation is believed to be beneficial for both parties (it has to be noted that there are costs related to university-industry cooperation as well (Hall et al. 2001, Hall et al. 2003, Laursen and Salter 2006)) and, moreover, to the whole society and its development, yet the level of university-industry cooperation is low, raises several questions. Why is the actual cooperation level low? What are the main barriers hindering university-industry cooperation? What is characteristic to the firms cooperating with universities? What is characteristic to the universities that cooperate with

firms? What could be done to increase university-industry cooperation? How could the linkages within the knowledge triangle be improved to support the cooperation between universities and industry? What is the role of the state in this process?

There are several theoretical and empirical papers on the actors of the national innovation system (NIS), including university-industry cooperation. Based on the literature on innovation studies, several research gaps can be found. Some of these gaps are addressed in this thesis. The lack of a comparative view across European countries is one of these gaps (addressed in Study 1 and Study 2). Providing a comparative view is important for understanding how the background settings (i.e. framework conditions) are related to the research findings, which of the result can be generalized and which are country-specific. This enables to give a better reasoning for the results as well as to put the research findings into context. At the same time, comparing countries with different background settings gives a better input for designing policy measures and finding the best practices.

Providing a comparative view gives the possibility to answer several questions mentioned above, e.g. what could be done to increase university-industry cooperation? How could the linkages within the knowledge triangle be improved to support the cooperation between universities and industry? What is the role of the state in this process?

As the competitiveness of the firm is dependent on the environment it operates in i.e. the national innovation system, it is important to understand the linkages between the actors of the system. Moreover, it is valuable to understand, which type of the actors are more likely to cooperate with each other. This is where Study 1 is contributing to the literature. In addition to the comparative view across European countries, also comparison between the cooperation partners (universities) based on their location is provided.

From the viewpoint of education as a significant input in terms of innovation, entrepreneurship education is gaining importance because there is a growing level of complexity and uncertainty in society due to globalisation (Gibb 2002). To adjust to the changing environment, there is a need to become more entrepreneurial irrespective of the field of activity (Gibb 2002). As can be seen from the reports of the Global Entrepreneurship Monitor, the level of entrepreneurial activities is low in Europe despite the increasing provision and promotion of entrepreneurship education (see, for example, Fiet 2001, Jones and English 2004, Löbler 2006, Krueger 2007, Higgins and Elliott 2011). This has initiated discussions how to teach entrepreneurship in a way that it would be more beneficial (Gibb 2002, Jones and English 2004) for the other actors within the innovation system, including innovating firms.

Already in the classical works of Schumpeter (1934) and Kirzner (1973), the role of the entrepreneur in the innovation process and for economic growth is emphasised. Entrepreneurship education can be seen as a possible driver of economic growth through increasing the intentions of becoming an entrepreneur (Rasmussen and Sørheim 2006, Matlay 2008, Raposo and do Paço 2011, Rauch

and Hulsink 2015). Much less attention is drawn to the different types of entrepreneurship education and how these types are related to innovation. In addition to plentiful previous research, studying the different types of entrepreneurship education also helps to understand how innovation and development are supported by entrepreneurship in terms of entrepreneurship education. Therefore, focusing on the teaching aspect of entrepreneurship education contributes to the knowledge about the relationship between innovation and entrepreneurship. Despite the significance of the topic, there is a lack of empirical papers studying the difference between the teaching approaches used in entrepreneurship education in terms of the outcomes of the education and its accordance to the needs of society. This is another major gap addressed in this thesis.

To sum up, this thesis is related to three different strands of innovation studies literature. However, all of them contribute to studying university-industry cooperation in the context of the national innovation system. The national innovation system itself is not in the main focus of the thesis but is used to provide a helpful context for the components related to university-industry cooperation (firms, universities and the government).

Aim and research tasks

The aim of this thesis is to provide insights into the core elements of university-industry cooperation in the context of the national innovation system with the emphasis on a comparative view of European countries. On the one hand, all three papers used in this thesis study university-industry cooperation, but at the same time, different studies focus on a different party of university-industry cooperation (Study 1 has firm characteristics in focus, Study 2 the governmental support measures and Study 3 the teaching approaches used by the universities). On the other hand, university-industry cooperation is studied on three levels: on the country (Study 2), firm (Study 1) and individual level (Study 3). Thus, this thesis provides an insight into the interaction between the different strands of innovation literature related to each of the three parties involved in university-industry cooperation.

To accomplish the aim of the thesis, the following research tasks were set:

1. Provide a theoretical overview of the framework for studying university-industry cooperation (Chapter 1.1)
2. Discuss the aspects of knowledge search that create the background for understanding university-industry cooperation (Chapter 1.2)
3. Give a systematic overview of the determinants of university-industry cooperation (Chapter 1.3)
4. Provide an overview of the importance of education in the innovation system (Chapter 1.4)
5. Identify and compare the determinants of university-industry cooperation across European countries (Chapter 2)

6. Build a data set to compare the measures directed at university-industry cooperation across European countries (Chapter 2)
7. Compare the results of traditional and experiential teaching approaches used in entrepreneurship education in terms of providing students with the knowledge, skills and attitude that support entrepreneurial activities (Chapter 2)
8. Discuss the empirical findings in the context of the national innovation system (Chapter 3)

Novelty of the thesis

This thesis consists of three studies that focus on different parties of university-industry cooperation within the innovation system. All of these studies contribute to the innovation studies literature, each of them being related to a specific actor inside the innovation system and therefore complementing each other in understanding university-industry cooperation.

Study 1 focuses on the determinants of university-industry cooperation and contributes to the literature of innovation studies in many ways. The major gap addressed in Study 1 is the lack of a comparative view when studying the determinants of university-industry cooperation. There is a growing number of studies covering this topic, but most of the previous studies analyse one country at a time. See, for example, Tether (2002), Laursen and Salter (2004), and Volpi (2014) using data for the UK; Busom and Fernándes-Ribas (2008), Segarra-Blasco and Arauzo-Carod (2008) and Guimón and Salazar (2014) focusing on Spanish data. There are also studies where more than one country is analysed, but in most of such cases the results are provided for pooled data (one model is estimated for all the countries). Therefore, these results do not reveal the differences in the determinants of university-industry cooperation between the countries analysed (see, for example, Mohnen and Hoareau 2003, Fontana et al. 2006, and Fernández López et al. 2014). These afore mentioned studies used data regarding several countries but did not provide a comparative view of those countries. In Study 1, separate models with the same set of variables are estimated for all the countries included in the study, which gives an opportunity to provide a comparative view across the analysed countries. The advantage of a comparative view is that the background settings of the countries can be included in the analysis as well. This in turn gives a better input for designing policy measures.

The second novel aspect of Study 1 is related to distinguishing between the locations of the universities, comparing the determinants of university-industry cooperation across cooperating with domestic and foreign universities, which is addressed in some of the previous studies (see, for example, Segarra-Blasco and Arauzo-Carod (2008) on Spanish data). Cooperating with foreign universities may on the one hand reflect the low quality of the domestic universities (Laursen et al. 2011, Fu and Li 2016) or the need for a specific type of knowledge

that is not provided by the local universities irrespective of their quality (Fu and Li 2016). On the other hand, it might be related to the foreign ownership of the firm. This results in universities from the location of the headquarters being preferred for cooperation and the parent firm determining the cooperation partners (Birkinshaw and Hood 1998). Analysing the determinants of university-industry cooperation across domestic and foreign universities enables to see which types of firms need knowledge outside the borders of the national innovation system. This in turn gives input for designing support measures for university-industry cooperation. At the same time, when the reason for cooperating with foreign universities is related to the low quality of domestic universities, steps can be taken to improve the quality of domestic universities.

The third gap addressed in Study 1 is related to the background settings of the countries, as on the basis of the comparative view it is possible to compare the development indicators (for example the income level, the quality of research institutions, the efficiency of the legal framework) of countries and show the differences in the determinants of university-industry cooperation across different development levels. There is a lack of this kind of information provided in the studies, mainly because most of previous research analyses one country at a time. Therefore, a comparative view of the determinants of neither cooperation nor their differences across indicators reflecting the development are provided. The background settings (reflecting the level of development) directly influence the cooperation between the actors within the national innovation system, including university-industry cooperation. Also, the determinants of cooperation are influenced by the national innovation system and its development level. The background settings (i.e. the framework conditions) can act both as incentives and barriers to university-industry cooperation (Polt et al. 2001). Therefore, it is expected that the determinants of university-industry cooperation vary across the different settings of the national innovation system. In countries with a well-performing innovation system, the overall cooperation level is expectedly higher because the system failures (hampering the cooperation) are better mitigated (OECD 1997, Smith 2000)

Study 2 provides a detailed overview and good background knowledge of the policy measures directed at supporting university-industry cooperation across European countries. The contribution of Study 2 lies in the in-depth description of these policy measures (who is eligible for which measure, who has to provide co-financing to qualify for the measure, if cooperating with universities is set as a mandatory requirement in the measure), compiling information about several European countries and building a dataset consisting of all measures directed at university-industry cooperation in these countries and thereby providing new insights into comparing this type of policy measures across European countries (i.e. a comparative view of policy measures directed at supporting university-industry cooperation). To conclude, Study 2 makes the contribution of using a unique and detailed dataset about the policy measures directed at university-industry cooperation that could also be used for further research.

In Study 3, the authors discuss the changing paradigms of teaching at the university level and choosing different teaching methodologies for entrepreneurship education to provide a higher level of learning outcomes. By learning outcomes, the factors supporting entrepreneurial activities are meant, namely the attitudes towards entrepreneurship, knowledge about entrepreneurship and entrepreneurial skills. Through this, universities also participate in the creation of knowledge needed by society (according to the typology of knowledge production, considering societal needs refers to Mode 2, which is discussed in Chapter 1.1) and do not only create knowledge, but also enable value creation through promoting innovation (which is what "fourth generation universities" do).

Study 3 is devoted to the entrepreneurship education provided by universities and thus Study 3 complements the other two studies with the focus being on the university as one of the important actors in the national innovation system. In addition to filling the gaps related to the literature on entrepreneurship education, Study 3 also contributes to the literature of innovation studies through the linkage of education and innovation. The purpose of Study 3 was to reveal how the universities' choices of teaching methods influence the possible value and usefulness of the education in the innovation process. Two types of teaching approaches are studied, those of the traditional and the experiential entrepreneurship education. The main difference highlighted in the literature is that the traditional teaching approach is related to the education about entrepreneurship while the experiential approach is related to the education for entrepreneurship (Levie 1999, Gibb 2002). The experiential entrepreneurship education is believed to provide a more appropriate set of skills and behaviours in terms of being an entrepreneur and is therefore seen as a more suitable approach for teaching entrepreneurship (Fiet 2001, Jones and English 2004, Löbler 2006, Rasmussen and Sørheim 2006, Krueger 2007, Higgins and Elliott 2011).

The main gap addressed in Study 3 is the lack of empirical studies comparing the outcomes of the traditional and experiential entrepreneurship education. There are both theoretical studies emphasising the differences in the learning outcomes of entrepreneurship education that depend on the teaching approaches (Gibb 2002, Jones and English 2004) and empirical studies comparing the outcomes of entrepreneurship and non-entrepreneurship students, but these are do not study the differences between the teaching approaches of entrepreneurship education (see, for example, Charney and Libecap 2000, Noel 2002, Graevenitz et al. 2010, Fayolle and Gailly 2015; for a literature overview of several papers studying the relationship between entrepreneurship education and entrepreneurial activities, see Dickson et al. 2008). While Study 1 is based on a narrower definition of university-industry cooperation, Study 3 is related to a broader definition. Due to the fact that one way for universities to contribute to the development of firms is through providing graduates with the "right" set of knowledge and skills that are needed for innovating, it is important to study whether and how the teaching approaches are related to the outcomes of education. For teaching different subjects, different approaches are suitable and

appropriate for maximising the matching of the needs of the firms and the set of knowledge and skills of the graduates.

All three studies make contributions to the field of innovation studies, whereas each of the studies emphasises a different strand in the innovation literature. At the same time, all three studies complement each other while focusing on different actors within the national innovation system and providing different views on the activities inside the innovation system. The interaction between and combination of different strands of innovation literature, however, all of which are related to university-industry cooperation, can be seen as one of the strengths of this thesis.

Structure of the thesis

This thesis consists of three chapters. The first chapter provides a theoretical framework for studying university-industry cooperation in the context of the national innovation system. The national innovation system itself is not the object of analysis in this thesis but a helpful framework to study university-industry cooperation. Chapter 1 consists of six sub-chapters, which are related to the evolution of universities that has made the university-industry cooperation possible, different models describing university-industry cooperation are also discussed in its first sub-chapter. The second sub-chapter creates the background for understanding university-industry cooperation in terms of the knowledge search, including the breadth and depth of the search. In the third sub-chapter, a systematised overview of empirical papers studying the determinants of university-industry cooperation is given. The fourth sub-chapter is devoted to the role of education in the innovation system. The fifth sub-chapter states the research questions based on the gaps found in the literature and the sixth sub-chapter describes the data and methods used in the thesis.

The second chapter consists of three empirical studies. Study 1 provides a comparative view across European countries on the determinants of university-industry cooperation (see Figure 1). Study 2 also focuses on a comparative view across European countries and describes policy measures directed at university-industry cooperation. Study 3 provides insights about the attitudes towards entrepreneurship, knowledge about entrepreneurship and entrepreneurial skills provided by different teaching approaches in relation to entrepreneurship education. All of the three studies provide an input for designing policy measures, but the aim of the thesis is not to give such recommendations.

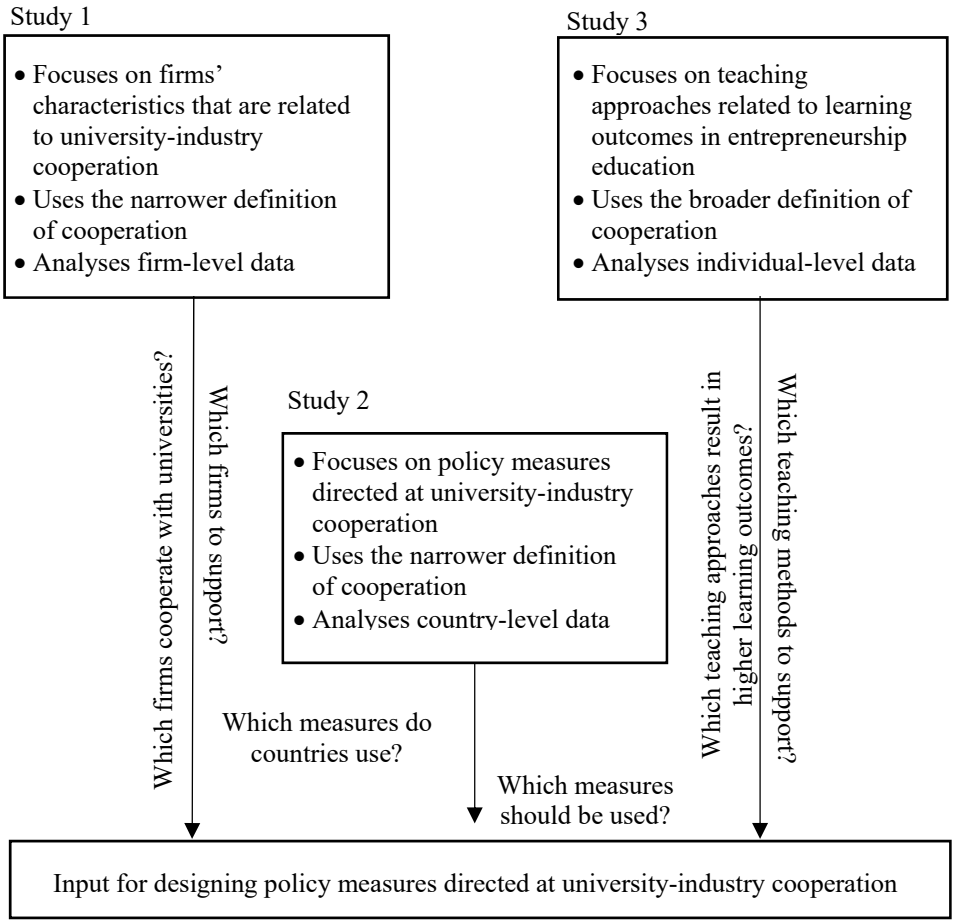

Figure 1. Overview of the three studies used in the thesis (compiled by the author).

The third chapter consists of three sub-chapters. The first of the sub-chapters discusses and synthesises the empirical findings of the three studies used in the thesis. The second sub-chapter draws conclusions and the last sub-chapter discusses the limitations of the thesis and provides ideas for further research.

Contributions of individual authors

All three studies in this thesis were written together with co-authors. In Study 1, the author of this thesis is the main author. This study was co-authored by Pierre Mohnen and Urmas Varblane. All authors contributed to the development of the research propositions, writing the theoretical part of the paper and contributed to improving the manuscript before and during the reviewing process. The author of the thesis is responsible for the empirical part of the paper; all calculations,

regression and cluster analyses were conducted by the author of the thesis. The author of the thesis is responsible for submitting the paper and replying to the reviewers' comments.

Study 2 was written together with Marge Seppo and Urmas Varblane. All authors contributed to the development of the research framework and writing the manuscript. The author of the thesis together with Marge Seppo is responsible for compiling the list of policy measures directed at university-industry co-operation, meaning that all policy measures provided by the Inventory of Research and Innovation Policy Measures were manually processed to distinguish between measures directed at university-industry cooperation and other policy measures in the database. The author of the thesis is responsible for all the statistical analyses conducted in the paper.

Study 3 is co-authored by Inna Kozlinska and Tõnis Mets. The author of the thesis contributed to the study with the empirical analysis. The analysis was conducted together with Inna Kozlinska who also wrote the results section of the analysis. Still, the author of the thesis provided her with knowledge about structural equation modelling throughout the writing of Study 3 and assisted her with comments and advice in all the stages of the process, both before and after submitting the paper, including managing the comments from the reviewers.

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1. THEORETICAL BACKGROUND FOR STUDYING UNIVERSITY-INDUSTRY COOPERATION

1.1. Evolution of the theoretical framework for studying university-industry cooperation

This chapter provides an overview of the changing role of universities, which accompanied by changes in other parties involved in university-industry cooperation has led to an increasing level of cooperation between universities and industry. In addition to the changing role of the university, the evolution of different theoretical models providing a framework for studying university-industry cooperation are discussed in this chapter, including different types of triple helix models, the concept of the knowledge triangle, changes in knowledge production modes and in models of innovation.

The changing role of universities has been caused by several factors. Wissema (2009) argued that one of the reasons behind the changing role of universities is globalisation. Other reasons pointed out by Wissema (2009) are the following: commercial activities (contribution to economic growth), the interdisciplinarity of research, an increasing number of students, and a lack of funding. At the same time, there are changes on the firms' side as well: it is not always beneficial for firms to do their own fundamental research. Therefore, they have started to look to universities as partners for cooperative research. This topic is related to the knowledge search of a firm and is described in Chapter 1.2.

Over time, four different generations of universities have been described in the literature and they are the following: the first generation or mediaeval or the traditional university, the second generation or the Humboldt university, the third generation or knowledge-subordinated university and fourth generation or university as a creator of its environment through transferring knowledge, technologies and ideas (Wissema 2009, Pawłowski 2009). The first generation universities had teaching as their main objective, which changed during the first academic revolution (taking place during the late 19th and early 20th century) when research as a second mission of universities was introduced (Etzkowitz and Webster 1998). The first academic revolution was followed by the second one, which was defined by Etzokwitz and Webster (1998: 21) as follows: "The second academic revolution is the translation of research findings into intellectual property, a marketable commodity, and economic development". Hence, the third mission of universities was indicated to be engagement to communities through social and economic development and the main role and objective of third generation universities was to create value through teaching and doing research that were accompanied by the exploitation of know-how (Wissema 2009, Etzkowitz and Viale 2010).

Recently, terms "the fourth generation of universities" and "the third academic revolution" have been discussed in the literature. Teaching, research (in terms of open innovation (Chesbrough 2003, 2006) that is discussed in detail in

the following Chapter 1.2) and enabling value creation and being the engine in local economies are seen as the objective and role of the fourth generation universities (Zuti and Lukovics 2015). In addition to a growing body of literature about universities as contributors to the local and regional economy, also in Lilles and Rõigas (2017) the authors showed that through human capital in terms of students in tertiary education, universities can contribute to regional growth, specifically to knowledge-intensive employment.

The third academic revolution is related to the emergence of entrepreneurial universities (see Clark 2001 for university transformation) and the importance of a university in an innovation process is on the increase. This means that universities are taking over the functions of industry as described with the triple helix III and also replace some industrial functions, including promoting innovation (Etzkowitz 2003; Etzkowitz and Viale 2010). An entrepreneurial university is seen to be fulfilling different tasks: firstly, to provide students with the necessary set of skills and knowledge to become entrepreneurs and secondly, to act in an entrepreneurial way itself (Schulte 2004). The emergence of the entrepreneurial university is dependent on the surrounding environment, specifically the entrepreneurial ecosystem which is defined as "a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory" (Stam and Spigel 2016: 1).

As the "third mission" of universities is emerging, also the traditional university-industry relations are changing (Etzkowitz and Leydesdorff 1998). Because of globalisation and increased competition due to globalisation as described by Wissema (2009) from the viewpoint of universities, changes on the firms' side are also taking place, meaning that the internal knowledge might not always be sufficient to stay in competition. Therefore, the need for external knowledge sources arises. Based on the Sappho-study (Rothwell et al. 1974), it can be concluded that for innovations to be successful, interactions with parties outside the firm are important. In the newer version of this kind of a study – Sappho revisited (Radosevic and Yoruk 2012), the authors also confirmed that cooperation is important for successful innovation activities.

While changes in both the university and industry (and also on the governmental level) in terms of their functions are evident, together with the government they form a "triple helix", which describes the relations between university-industry-government. The triple helix model was introduced by Etzkowitz and Leydesdorff in the 1990s (see Etzkowitz 1993, Etzkowitz and Leydesdorff 1995).

The model of the triple helix has three possible ways how the relationship between the university, industry and government can exist. The historical version of the triple helix (triple helix I) describes the state as the owner of the leading role in the model, by directing and controlling the relationship between the university and industry while both of these parties are encompassed by the state. In this kind of a model, the role of universities is limited to teaching and possibly research as well. The triple helix II consists of three highly separated parties having a limited relationship, this model is also called the *laissez-faire*

model of the triple helix. In the second model, universities are seen as providers of basic research and education (trained persons), the knowledge transfer between the university and industry exists through publications and graduates. Most commonly in use in most countries is the third version of the triple helix (triple helix III) where the borders between the university, industry and government overlap and each of the institutions is taking over the roles of the others. (Etzkowitz and Leydesdorff 2000, Etzkowitz 2003)

"Thus universities take on entrepreneurial tasks like marketing knowledge and creating companies, while firms develop academic dimension, sharing knowledge among each other and training employees at ever higher skill levels" (Leydesdorff and Etzkowitz 1998: 198). From the governmental side, also additional functions emerge, for example the role of the "public entrepreneur and venture capitalist" (Etzkowitz 2003). Through and due to the overlapping roles of the university, industry and government, active cooperation between the parties takes place.

In addition to the triple helix model, models for quadruple and quintuple helices have been described in the literature as well. In the quadruple helix, the "media-based and culture-based public" and "civil society" are added to the previously known system of the university, industry and government. The quadruple model draws attention to the integration of the public and society into the innovation systems and puts the triple helix model into a context. (Carayannis and Campbell 2009)

The quintuple helix adds "natural environments of society" to the quadruple helix and through that contextualises the quadruple helix in turn. Natural environments can be seen as drivers for knowledge production and innovation systems. (Carayannis and Campbell 2011, Carayannis et al. 2012) Leydesdorff (2012) argued that in the changing environment, there could be even more helices in the model.

A recent concept that is connecting the different actors of an innovation system (similarly to the model of the triple helix) but is more focused on the activity-side compared to the triple helix model where the emphasis is on the actors, is the concept of the knowledge triangle (Unger and Polt 2017).

The knowledge triangle is a concept that overlaps to a great extent with other concepts discussed in Chapter 1.1, mainly with the model of the triple helix, but it is also related to the entrepreneurial university and the third mission of universities (Unger and Polt 2017).

The importance of concept of the knowledge triangle in the light of this thesis is that it connects education, research and innovation that are all in the focus of this thesis, therefore providing a central framework for studying university-industry cooperation.

Education, research and innovation are located in the corners of the knowledge triangle and knowledge moves from each of the corners to the other two corners, forming a circular flow of knowledge (Sjoer et al. 2016) as seen in Figure 2.

As stated by the European Commission (2005), universities play an important role in all of these three corners. Moreover, the corners of the knowledge triangle reflect the three missions of universities (Lassnigg et al. 2016) and the concept of the knowledge triangle is aimed at finding ways to better integrate these three corners of the triangle (Cervantes 2017). The corners of the knowledge triangle represent the drivers of the competitiveness of the economy (Sjoer et al. 2016).

As found in several studies (different waves of the CIS, a study by Davey et al. 2011, 2018), the level of cooperation between the university and industry is low and therefore, the benefits that could be gained from the university and used for increasing the level of competitiveness and economic growth remain also smaller than their potential level could be.

The need for the concept of the knowledge triangle comes from the necessity to change the role of universities so that the outcome of universities (education and research) could be better used for innovation, including (but not limited to) innovative cooperation with industry (Sjoer et al. 2016).

The concept of the knowledge triangle is accompanied by new challenges to the universities that are actively participating in all of the corners of the knowledge triangle. In addition to what was known as a way of working at the universities, the knowledge triangle brings innovation to the centre of the university. Also, the transfer of knowledge is different in the triangle – instead of a one-way transfer, the transfer of knowledge forms a circular flow, which in turn demands for a new way of interaction between the parties included. (Sjoer et al. 2016)

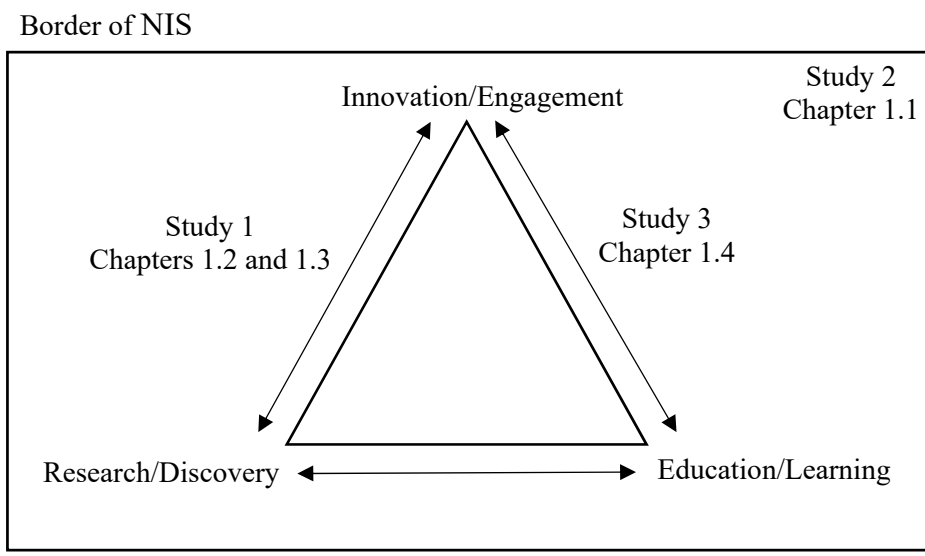

Figure 2. The knowledge triangle (Markkula 2011, Sjoer et al. 2016 with modifications by the author)

In terms of this thesis, the side of the knowledge triangle that is between innovation and research is related to Study 1 where the determinants of university-industry cooperation and the background settings of countries are analysed, this side of the triangle is also connected to Chapters 1.2 ("Knowledge search") and 1.3 ("Firm-level determinants of university-industry cooperation") of this thesis. The side between education and innovation is related to Study 3 that discusses the university programmes that are intended for creating the necessary knowledge and competencies in the field of entrepreneurship. The general importance of education in the innovation system is discussed in Chapter 1.4.

Study 2 gives an overview of different measures that are directed at supporting university-industry cooperation, meaning also the improvement of the knowledge flows between the different corners of the knowledge triangle. The justifications of policy interventions are discussed in Chapter 1.1. In addition, Chapter 1.1 provides the theoretical framework for studying university-industry cooperation. Therefore, both Study 2 and Chapter 1.1 are related to the knowledge triangle as a whole, not focusing on single sides of the triangle. The third side of the knowledge triangle between research and education is not covered in this thesis.

While the role of universities and their interaction with the other parties of the innovation system and the environment is increasing, also the production of knowledge is changing in time. The change of knowledge production from Mode 1 to Mode 2 is related to both the type of knowledge that is produced and how it is produced (Gibbons et al. 1994). Mode 1 reflects the "old paradigm of scientific discovery" while Mode 2 stands for "socially distributed knowledge" (Nowotny et al. 2003). In Mode 1, by knowledge production basic research in universities is meant, producing knowledge is directed by different cognitive and social norms and is not related to the needs of society (Gibbons et al. 1994; Carayannis and Campbell 2012). The main difference between Mode 1 and Mode 2 is that in Mode 2 knowledge is produced in the "context of application", meaning that "knowledge is always produced under an aspect of continuous negotiation and it will not be produced unless and until the interests of various actors are included" (Gibbons et al. 1994: 4). This kind of knowledge produced has to be useful, either for industry or for the government (Gibbons et al. 1994). While in Mode 2 the three phases of discovery, application and the use of knowledge are assumed to be closely integrated, in Mode 1, these phases are executed separately (Zheng 2010).

The modes of knowledge production are not limited to two, there is also Mode 3. Mode 3 is about knowledge creation, diffusion and use in "innovation networks" and "knowledge clusters" (Carayannis and Campbell 2006) where active interactions and engagement between the university, industry, government and society exist (Carayannis and Campbell 2012).

For the discussion of the shortcomings of the triple helix model and the modes of knowledge production, see, for example Krücken (2002, 2003), Shinn (1999, 2002), and Tuunainen (2005), which review the recent critique addressed to these approaches.

Table 1. The evolution of the framework for studying university-industry cooperation

Academic revolution	I academic revolution		II academic revolution	III academic revolution
Formation of universities	I generation universities	II generation universities	III generation universities	IV generation universities
Mission/role of the university	Teaching	Teaching Research	Teaching Research Engagement to community	Teaching Research Engagement to community Creator of environment
Mode of knowledge production	Mode 1: Old paradigm of scientific discovery		Mode 2: Socially distributed knowledge	Mode 3: Innovation networks and knowledge clusters
Generation of innovation models	I generation of innovation models: technology push	II generation of innovation models: market pull	III and IV generations of innovation models: coupling and integrated	V generation of innovation models: systems integration and networking

Source: compiled by the author based on Rothwell 1994, Gibbons et al. 1994, Etzkowitz and Webster 1998, Clark 2001, Nowotny et al. 2003, Carayannis and Campbell 2006, Wissema 2009, Pawłowski 2009, Godin 2009, Etzkowitz and Viale 2010, Zuti and Lukovics 2015.

While the triple helix models describe the interaction between the university, industry and government, the linear model of innovation is one of the first frameworks for understanding the relationship between science and economy. In this simple model, the process of innovation is described as starting with basic research, followed by applied research and development, and ends with production and diffusion (Godin 2009). The linear model encompasses the first two generations of innovation processes, which are "technology push" (the first generation) and "market-pull" (the second generation). The third generation model – the "coupling" model of innovation – is a non-linear model with feedback where the successful innovation process was driven by "key individuals" (Rothwell 1994, Niosi 1999) that interact with each other (Tidd et al. 2005). The keywords of the fourth generation of the innovation process (integrated innovation process) are integration and parallel development (Rothwell 1994) where the emphasis is on the technological alliances and linkages as well as on the integration within firms and with suppliers and customers, also links between the university and industry were increasing (Niosi 1999, Tidd et al. 2005). The fifth generation innovation process is a "process of systems integration and networking" and is related to continuous innovation (Rothwell 1994, Tidd et al. 2005).

These generations of universities, academic revolutions, missions of universities, models of triple, quadruple and quintuple helices, different modes of knowledge production and innovation models are all related to each other. For an overview of their emergence over time, see Table 1.

As the role of universities and hence their interaction with the surrounding environment has changed over time, also the models describing the university's relations with other parties have changed and become more complex and systematic (see Etzkowitz and Leydesdorff 2000, Etzkowitz 2003, Carayannis and Campbell 2009, Carayannis and Campbell 2011, Carayannis et al. 2012). The systemic view of the innovation process and the development of the concept of the national innovation system as the relationships of different actors both from the private and public sector, whose interaction is related to the creation, diffusion and usage of new technologies (Freeman 1987, Lundvall 1992, Nelson 1993), is seen as a helpful context for studying the relationship between the university and industry. Figure 3 illustrates the national innovation system and shows how the three studies of this thesis are related to the context of the national innovation system.

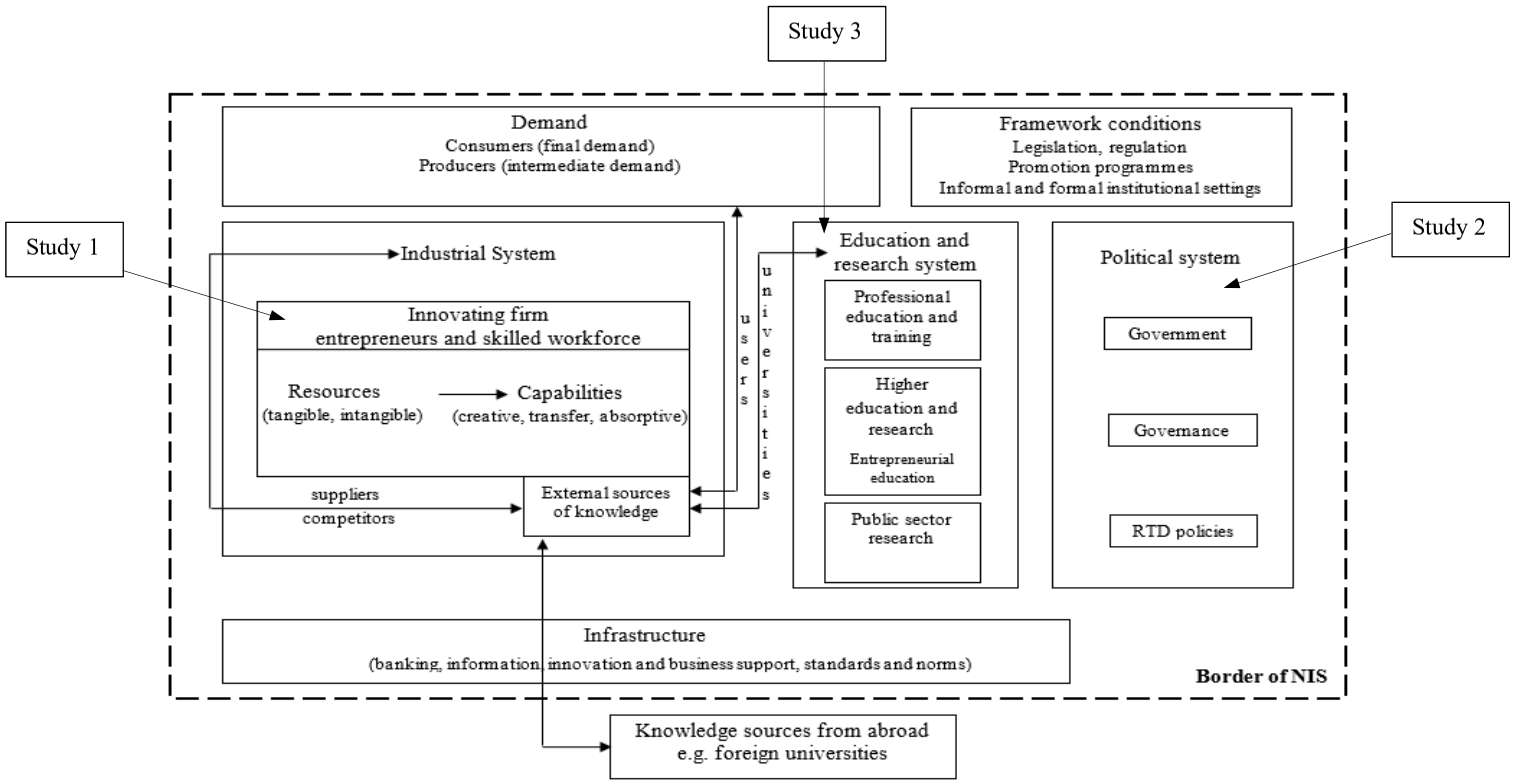

Figure 3. Knowledge sources of firms within the national system of innovation (Kuhlmann and Arnold 2001, Tether and Tajar 2008 with modifications by the authors).

In terms of university-industry cooperation, the role of the government as one of the participants has also changed from having the leading role in university-industry cooperation to an equal partner to the university and industry (Etzkowitz 2003). The reasoning behind the government being one of the participants in the university-industry cooperation models lies in system failures[1], although the rationale for policy interventions in terms of knowledge is based on the market failure analysis (Smith 2000). For an explanation of the relationship between the market and system failures (both as a rationale for policy interventions), see, for example Gustafsson and Autio (2011), García Manjón and Romero Merino (2012), Bleda and del Rio (2013).

Jacobsson and Bergek (2006) pointed out three reasons why market failures are not an appropriate approach to justify policy interventions in case of innovation systems. Their first argument was that in a dynamic environment, finding a static optimum cannot be an objective for policy interventions. As a second reason, they argued that the market failure approach does not provide enough guidance for policy interventions and thirdly, innovation is related to different components of the innovation system, including institutions and networks, and is not only related to the actors and characteristics of the market (Jacobsson and Bergek 2006). Smith (2000) argued that the market failure approach (see Arrow 1962) is dealing with the problem of an under-supply of knowledge (deviation from the optimal creation of knowledge) while in the system failures approach the intervention of the government is justified with the systematically weak performance of some areas of the system of innovation (Smith 2000)[2]. Edquist et al. (1998: 18) defined system failures as "the absence or ineffective working of the key evolutionary mechanisms that are at the base of industrial development."

A list of system failures (or system imperfections) is provided by Klein Woolthuis et al. (2005) based on failures addressed in previous literature, including in Carlsson and Jacobsson (1997), Edquist et al. (1998), Smith (1999) among others. This list of failures consists of eight failures, namely infrastructural failure, transition failure, lock-in/path dependency failure, hard and soft institutional failure, strong and weak network failure and capabilities' failure.

Infrastructural failure includes both infrastructural provisions and investments. According to Smith (2000), firms interact with physical infrastructures (related to energy and communications) and with science-technology infrastructures (for example with universities, technical institutes, libraries).

Transition failures mean that the technological capabilities of firms are limited; therefore, they are not able to follow changes and developments in the

[1] In the literature, the terms "system failure" and "systemic failure" are both used, referring to the same phenomenon. In the current thesis, the term "system failure" is used.

[2] While "market failures" as the rationale for policy intervention comes from the neoclassical theory, the "system failure" approach derives from the evolutionary theory. For the comparison of these theoretical frameworks, see for example Chaminade and Edquist (2010).

field of technology (Smith 2000). Lock-in failure is related to path dependency, meaning that not only the firms are unable to follow technological changes (due to transition failures), but also the whole socio-economic system is unable to change towards a new technological paradigm (Smith 2000). Capabilities' failure means the lack of capabilities for adopting new technologies (Klein Woolthuis et al. 2005) and is closely related to transition failure. The capabilities' failure along with other capabilities also includes the lack of absorptive capacity (OECD 1997). In addition, there is another failure called learning failure (Edquist et al. 1998), which also describes a similar phenomenon: the inability of firms to learn fast and therefore not being able to move towards new technologies.

Failures in the framework of regulations are called institutional failures (Smith 2000). Jacobsson and Johnson (2000) also point out a list of failures related to institutions, namely legislative failures, failure in the educational system, a skewed capital market and the underdeveloped organisational and political power of new entrants. Two types of institutional failures are distinguished in the literature, namely hard and soft institutional failures (Carlsson and Jacobsson 1997). By hard institutions, formal institutional mechanisms are meant (Klein Woolthuis et al. 2005), these kinds of failures were described, for example, in Smith (2000) and are related to the appropriability traps explained in Edquist et al. (1998). Soft institutional failures consist of political culture and social values (Smith 2000, Jacobsson and Johnson 2000).

Network failures are related to connections between the actors of a system and are divided into two groups: weak and strong network failures. A weak failure means that the connections between the actors are not well established, meaning that there is a lack of connections between the actors with an "overlapping technology base", a strong network failure means having close connections, but not changing the knowledge necessary for the other actors. (Jacobsson and Johnson 2000)

Another failure discussed in the literature, which is related to the weak network failure, is complementarities failure (Edquist et al. 1998) which means that the positive effect of complementarities does not occur if the actors are not connected. The lack of interaction is seen as a system failure also in the national innovation system overview by the OECD (1997).

For a detailed overview of different failures discussed in the system failure literature, see, for example, Hauknes and Nordgren (1999), Wieczorek and Hekkert (2012).

In addition, another set of failures complementing the system failures was proposed by Weber and Rohracher (2012) called "transformational failures". The authors argued that in a changing environment (transformation) there are additional justifications for policy interventions: directionality failure, demand articulation failure, policy coordination failure, and reflexivity failure. For an

explanation of these failures, see Weber and Rohracher (2012)[3]. In order to extend the policy coordination failure, Binz and Truffer (2017) introduced the global innovation system framework with global policy coordination failure.

System failures and their extensions provide a reasoning for policy interventions and therefore provide explanations for the design of different policy measures discussed in Study 2.

Chapter 1.1 gave an overview of the changed roles of universities, firms and the government, which in turn explains the interaction and cooperation between them. These three parties and their interaction, which is related to the creation, diffusion and usage of knowledge, can be seen as the actors of the national innovation system, thus a short overview of innovation models was also provided in this chapter. As the university and its role was central in Chapter 1.1, the following Chapter 1.2 has the firms' perspective in focus, specifically the firms' knowledge search.

1.2. Knowledge search

Chapter 1.2 focuses on the topic of the knowledge search of a firm, discussing approaches including resource-based view, dynamic capabilities, and open innovation.

According to Penrose (1959, 1960), a firm is a "pool of productive resources". While in earlier studies, resources were mainly restricted to labour, capital and land, in Penrose's view, the spectrum of possible resources is wider (Wernerfelt 1984).

A definition of the resources given by Wernerfelt is the following: "By a resource is meant anything which could be thought of as a strength or weakness of a given firm" (Wernerfelt 1984: 172). Teece et al. (1997: 516) added the dimension of imitation: "Resources are firm-specific assets that are difficult if not impossible to imitate." The focus of this thesis is knowledge as one of the most important resources of a firm in the current knowledge-based society. The significance of knowledge as a prerequisite for the performance of the entrepreneurial function and thereby for innovation was discussed already by Schumpeter (1912) in a way that an entrepreneur should have access to the knowledge necessary for innovating. In the era of globalisation, firms cannot rely only on their internal knowledge but have to look for external knowledge as well to stay in the competition.

The sources of competitive advantage in a rapidly changing environment have the central role in the dynamic capabilities approach (Teece et al. 1997). The approach of dynamic capabilities is built upon several earlier approaches, including resource-based view. Eisenhardt and Martin (2000: 1106) defined dynamic capabilities as: "… specific strategic and organizational processes like

[3] These failures are not directly related to policy measures directed at university-industry cooperation and therefore are not discussed in this thesis.

product development, alliancing, and strategic decision making that create value for firms within dynamic markets by manipulating resources into new value-creating strategies."

In comparison to the resource-based view, which states that the firms' competitive advantage lies within the use of resources, not just having the resources (Penrose 1960)[4], the view of dynamic capabilities sees the constant renewing of competencies as the source of competitive advantage with the emphasis on change, both in the surrounding environment and inside the firm as well (Teece et al. 1997) while the resourced-based view does not "survive" in the course of the rapid changes in market conditions (Eisenhardt and Martin 2000). For the isolating mechanisms for creating a competitive advantage in terms of resource-based view, see Mahoney and Rajendran Pandian (1992).

At the same time, Eisenhardt and Martin (2000) argued that for creating a competitive advantage, dynamic capabilities are not sufficient because they can be duplicated; therefore, the competitive advantage is related to the set of resources and not to capabilities.

External knowledge as a critical factor for innovating was discussed by von Hippel (1988) when he highlighted that innovation sources are not limited to product manufacturers but can be found outside the firm as well. Penrose (1960) argued that for development, firms have two types of resources: those that the firm has previously acquired (internal resources) and those that have to be acquired outside the firm (external resources). Similar findings to von Hippel about external knowledge can be also found in Cohen and Levinthal (1990), and Klevorick et al. (1995).

The use of external knowledge is the basis for the paradigm of open innovation that suggests that constant development cannot take place in isolation. There have been discussions in the literature whether open innovation is a novel concept or not. For example, Groen and Linton (2010) initiated a discussion on the topic "Is open innovation a field of study or a communication barrier to theory development?" in Technovation. Several authors commented on that, for example von Hippel (2010), Linstone (2010), di Benedetto (2010), von Krogh (2011). There is a literature overview concerning the novelty of open innovation in Altmann et al. (2011).

The definition of "open innovation" provided by Chesbrough is as follows: "Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology" (Chesbrough 2003: XXIV). In another definition of "open innovation", it is stated that "open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation" (Chesbrough 2006: 1). Chesbrough and Bogers (2014: 17) provided a more recent definition of open innovation that is developed taking into ac-

[4] Also, in the Schumpeterian view, the resources had a significant role for developments. According to Schumpeter (1912), the allocation of resources to form "new combinations" is seen as the main function of the entrepreneur, which leads to economic development.

count the linkages between "open innovation" and the previous literature: "distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model." These flows of knowledge may involve knowledge inflows to the focal organisation (leveraging external knowledge sources through internal processes), knowledge outflows from a focal organisation (leveraging internal knowledge through external commercialisation processes) or both (coupling external knowledge sources and commercialisation activities).

Different types of knowledge sources, including external sources, are still actively studied and there is a growing body of literature about knowledge search and open innovation (see, for example, Laursen and Salter 2006, Lee et al. 2010, Köhler et al. 2012, Bogers et al. 2017, Criscuolo et al. 2017; for an overview of the main contributors to innovation search, see Laursen 2012; for an overview of the most cited studies and examples of empirical papers on openness, see Dahlander and Gann 2010). Important knowledge for innovative ideas can be gained, for example, from clients, suppliers, competitors, universities, public research institutions, commercial laboratories etc.

Acquiring and using external knowledge is not always easy and requires changes on the firm level. First of all, Cohen and Levinthal (1990) argued that for the efficient use of external knowledge, there has to be relevant prior knowledge which can be called "absorptive capacity". Nelson and Winter (1982) argued that the strategy for searching is related to the prior skills and experience the firm has. Empirical results in Leiponen (2005) also showed that the skills of employees are complementary to firms' innovation activities. Hence, human capital is seen as a key factor for innovating (Dakhli and De Clercq 2004, Subramaniam and Youndt 2005, Vinding 2006). Therefore, universities as providers of human capital through graduates, among other channels, can be seen as an important source for innovations. The role of education in the innovation process is described in Chapter 1.4.

In addition to the lack of absorptive capacity, there can be other challenges in engaging in open innovation (see, for example, Salter et al. 2014 on coping with open innovation, Salter et al. 2015 on individual level openness).

In organisational learning, exploration and exploitation are believed to be the two options for a firm to learn (March 1991). According to March: "[e]xploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution." (March 1991: 71). This means that exploring is related to uncertainty while the results of exploitation are predictable. In the study conducted in the global robotics industry, it was revealed that contradictory to the organisational learning research (March 1991), searching can be looked at as two-dimensional, consisting of depth and scope where the level of exploitation is reflected by the depth of the search and the level of exploring new knowledge is described by scope (Katila and Ahuja 2002).

The idea of two-dimensional search is further elaborated by Laursen and Salter (2006) who introduced the concept of "breadth" and "depth" to external knowledge search strategies, from which breadth is more studied compared to depth. In addition to previous research, Laursen and Salter (2006) contributed to the literature by studying external search in addition to the internal one.

Laursen and Salter (2006) argued that those with higher breadth and depth indicators tend to be more innovative, but it has to be noted that the relationship between openness (measured with breadth and depth) and innovative performance is not linear and at one point, additional search will not bring about innovation anymore. Also Leiponen and Helfat (2010) stated that the diversification of sources of knowledge is likely to increase the probability of successful innovations because the more knowledge sources the firm accesses, the higher the probability to get the "right" knowledge for successful innovations.

In their study conducted in the optical disk industry, Rosenkopf and Nerkar (2001) found that breadth both in the sense of organisational and technological borders is related to technological development whereas crossing both borders is accompanied by the highest impact on development.

In addition to promoting innovation performance, some knowledge sources can be complementary to each other; therefore, using and combining knowledge from different sources might result in better innovation performance or productivity growth (on complementary effects, see, for example, Geroski et al 1993, Veugelers and Cassiman 1999, Belderbos et al. 2004, 2006, Cassiman and Veugelers 2006, Roper and Arvanitis 2012, Ardovino et al. 2014, Grimpe and Sofka 2016).

Although the broadness of search has found empirical support in the literature (see Laursen and Salter 2006, Leiponen and Helfat 2010, Leiponen and Helfat 2011, Criscuolo et al. 2017; for a comparison between manufacturing and services, see Leiponen 2012; for a comparison between small and large firms, see Spithoven et al. 2013, Vahter et al. 2014, Brunswicker and Vanhaverbeke 2015), there are factors inhibiting broad searches. For example, underestimating the uncertainty in the innovation process and its outcomes will result in searches that are not broad enough (Leiponen and Helfat 2010). Levinthal and March (1993) emphasised the myopia of learning, occurring in three different forms and resulting in privileging the short-run perspective, ignoring the broader picture and overlooking failures which all inhibit broader searches.

In the literature, there has been a discussion on the usage and benefits of external knowledge through different approaches described in this sub-chapter. Following the discussion about knowledge search, one particular source of knowledge – the university – is in the focus of this thesis which is why the next chapter is devoted to the characteristics of firms using external knowledge from universities.

1.3. Firm-level determinants of university-industry cooperation

This sub-chapter provides a systematic overview of the determinants of university-industry cooperation. Determinants that have gained more attention in the empirical papers are going to be discussed in this sub-chapter.

Firms have a wide variety of external knowledge sources to choose from, different knowledge can be gained from different partners and all partners have their specific characteristics which can make cooperating with them, depending on their characteristics, both easier and more difficult. Cooperation with other partners and the barriers on cooperation are not discussed in this thesis because it is not in its focus.

However, it has to be noted that the university as a cooperation partner is different from other possible cooperation partners; see, for example Miotti and Sachwald (2003), Segarra-Blasco and Arauzo-Carod (2008), Busom and Fernándes-Ribas (2008), Carboni (2013) for a comparative view of cooperation determinants across several cooperation partners.

Not only universities[5] themselves are different from other cooperation partners, but also the knowledge provided by the universities might differ from the knowledge provided by other partners. This can be illustrated with the statement by Klevorick et al. (1995) that scientific knowledge can be seen as the most powerful and the most important source in the case of technological opportunities in the long run. The contribution of science to technology has been pointed out also in Brooks (1994) where he highlighted six ways of contributing, new knowledge as a source of ideas, and the creation of a knowledge base among others.

There are several empirical studies exploring the relationship between the university and industry, raising different research questions: which firms are more likely to cooperate with universities (for an overview of empirical research on the determinants of cooperation, see for example Fernández López et al. 2014), what the main drivers and barriers are (Kleinknecht 1989, Mora Valentín 2000, Hall et al. 2001, Hall et al. 2003, Cozzarin 2008, Bruneel et al. 2010, Davey et al. 2011) on university-industry cooperation, which channels (Brennenraedts et al. 2006, D'Este and Patel 2007, Bekkers and Bodas Freitas 2008, Perkmann and Walsh 2008, Davey et al. 2011, 2018, D'Este and Perkmann 2011) can be used for cooperating with universities, how to support (Seppo et al. 2014) university-industry cooperation, whether university-industry cooperation is beneficial for the cooperating parties (Cohen et al. 2002, Belderbos et al. 2006, Arvanitis et al. 2008, Eom and Lee 2010, Huang, Yu 2011, Temel et al. 2013).

This chapter focuses on the topics of which firms cooperate with universities, what the characteristics describing a firm that cooperates with universities

[5] Under the term university, other higher education institutions as well as governmental and other public sector research institutions are meant.

are. There is a growing body of literature on university-industry cooperation, including the determinants of cooperation. In previous studies, data from different countries and different innovation surveys have been used, see Appendix 2 for an overview of some empirical studies.

Despite the increasing number of studies related to the determinants of university-industry cooperation, the literature is lacking in the comparative view of the determinants of university-industry cooperation. Several studies use data for a single country (for example Tether (2002) and Volpi (2014) on the UK, Capron and Cincera (2003) on Belgium, Miotti and Sachwald (2003) on France, Busom and Fernándes-Ribas (2008) and Guimón and Salazar (2014) on Spain) or a smaller group of European countries while the econometric models are estimated based on pooled data, therefore not providing a comparative analysis of countries (for example Mohnen and Hoareau 2003, Fontana et al. 2006, Fernández López et al. 2014). Bellucci and Pennacchio (2014) differ from the other afore-mentioned studies by using data for 14 European countries but still do not offer a comparative perspective, instead a pooled estimation for all the countries together is provided. In terms of a comparative view, an example of a comparison of five European countries can be found in Cardamone and Pupo (2015).

Before discussing the results of the previous papers on the determinants of university-industry cooperation, the term university-industry cooperation is explained, how it is used in the thesis. As seen from Appendix 2, many of the studies use the CIS questionnaire as the data source for their analysis. In the CIS, university-industry cooperation is defined as follows (Eurostat 2017): "Innovation co-operation is active participation with other enterprises or institutions on innovation activities. Both partners do not need to commercially benefit." Pure contracting out of work with no active co-operation is not included under innovative cooperation (Eurostat 2017). Such cooperation is called innovative and as is going to be discussed in the chapter of limitations (see Chapter 3.3), technologically innovative firms are required to answer the questions concerning cooperation partners. Therefore, it has to be taken into account that in terms of the CIS questionnaire, a specific field is considered as cooperation.

In the study of European university-business cooperation by Davey et al. (2011, 2018), cooperation is considered in a broader sense compared to the CIS questionnaire and is defined as follows (Davey et al. 2011: 25): "all types of direct and indirect, personal and non-personal interactions between HEIs[6] and business for reciprocal and mutual benefit including: collaboration in R&D, personnel mobility (academics, students and business professionals), commercialisation of R&D results, curriculum development and delivery, lifelong learning, entrepreneurship and governance."

The idea behind university-industry cooperation in the current thesis is more related to the definition provided by the study of Davey et al. (2011, 2018), cooperation can occur through several channels and does not have to be limited to cooperation only related to innovation activities; moreover, all activities ac-

[6] HEI – higher education institutions.

companied by knowledge transfer are considered as university-industry cooperation (see the list of different channels of knowledge transfer between the university and industry for example in Brennenraedts et al. 2006, D'Este and Patel 2007, Bekkers and Bodas Freitas 2008). The importance of the cooperation related to education has been increasing recently (Afonso et al. 2012, Kunttu 2017, Davey et al. 2018). University-industry cooperation through education is in the centre of Study 3.

Both of the definitions have their advantages. On the one hand, the narrower definition of cooperation makes it easier to measure the level of cooperation, because it is limited to certain activities and is easier to determine. On the other hand, narrowing the cooperation down to certain activities may underestimate the level of cooperation in a broader sense because all firms cooperating with universities are not doing it through R&D activities.

However, in the current thesis, the breadth of university-industry cooperation depends on the particular study and comes from the limitations of the data used. For example, because Study 1 is based on data from the CIS questionnaire, a broader definition of cooperation is not applicable to this study. Study 2 uses data from both the CIS questionnaire and the study by Davey et al. (2011). Therefore, while analysing data from different data sources, the definition of that particular data source has to be kept in mind. As discussed previously in the thesis, Study 3 is related to university-industry cooperation through the broader definition of cooperation.

In the following paragraphs, the determinants of university-industry cooperation are introduced and by university-industry cooperation, active participation in innovation activities is meant. Due to the limitations of the CIS questionnaire, the determinants of university-industry cooperation found in the literature are applicable to firms that are already technologically innovative. Therefore, the determinants of university-industry cooperation in terms of innovation activities can be different for non-innovative (or not technologically innovative) firms.

The most analysed variable among the determinants of cooperation is firm size. For example, firm size has been studied by Tether (2002), Mohnen and Hoareau (2003), Capron and Cincera (2003), Miotti and Sachwald (2003), Laursen and Salter (2004), Fontana et al. (2006), Busom and Fernándes-Ribas (2008), Segarra-Blasco and Arauzo-Carod (2008), Eom and Lee (2010), Fernández López et al. (2014), Bellucci and Pennacchio (2014), Guimón and Salazar (2014), Volpi (2014) and Cardamone and Pupo (2015). However, contradictory empirical results in relation to the relationship between firm size and the probability to cooperate with universities exist, these results vary based on the data used, depending on the countries analysed and the variables measuring firm size (see Rõigas et al. 2018). Most of the studies based on European data reveal that the probability to cooperate with universities increases with firm size, with the exception of Fernández López et al. (2014) in the study on pooled data including Spain, France, and Portugal where no statistically significant relations between cooperation and firm size were found when firm size was measured by

four different indicators. Also research by Eom and Lee (2010) on Korean data resulted in insignificant relationships.

The reasoning behind using firm size as one of the variables describing the probability to cooperate with universities is related to the firm's internal resources. On the one hand, larger firms have more internal resources (compared to smaller ones) and as cooperation requires resources, larger firms are more likely to cooperate with universities. Another reason for larger firms to cooperate more is their awareness of the capabilities of cooperation partners. (Kleinknecht 1989, Tether 2002, Miotti and Sachwald 2003, Capron and Cincera 2003, Laursen and Salter 2004, Tether and Tajar 2008)

On the other hand, smaller firms have fewer internal resources. Therefore, the need for external knowledge might be higher for them (van de Vrande et al. 2009). Empirical results of Vahter et al. (2014) suggested that smaller firms can have higher innovation performance when using an extensive set of innovation partners (compared to larger firms).

Another reason why larger firms might be more likely to cooperate with universities, is that according to Arrow (1962) they are better at capturing property rights compared to smaller firms. The issue of property rights is seen as one of the barriers of cooperating with universities (Mora Valentín 2000, Davey et al. 2011), therefore it might be easier for larger firms to overcome this particular barrier.

Symeonidis (1996) provided an overview of studies that have tested the Schumpeterian hypothesis (Schumpeter 1942) about firm size and market power being the determinants of innovation. Symeonidis (1996) compiled a list of reasons why size and market power can give advantages in terms of innovation activities, including scale and scope economies, the ability to undertake several projects simultaneously, therefore spreading the risks. Also access to external funding can be better for larger firms and firms with higher market power have more internal resources to finance different activities at the same time (Symeonidis 1996). Spreading the risk is also related to university-industry cooperation, because the results of the cooperation are uncertain (Cozzarin 2008) and therefore might not be acceptable for smaller firms, which do not have the capability to engage in several projects at the same time.

Similarly to the case of firm size, being a part of an enterprise group can be seen both as having a positive and a negative relationship with university cooperation. Firms that belong to a group have access to internal knowledge within the enterprise group and might have no need for external knowledge (Tether 2002). However, belonging to a group makes it easier to find the right partners because of networks (Mohnen and Hoareau 2003), knowledge pooling (Tether 2002) and resources that can be allocated to searching for innovation partners (Miotti and Sachwald 2003).

In addition, empirical results concerning belonging to an enterprise group give mixed results: there are studies that find a positive relationship between belonging to a group and cooperating with universities (for example Tether 2002, Segarra-Blasco and Arauzo-Carod 2008), some studies provide results with

negative relationships (for example, Mohnen and Hoareau 2003, Miotti and Sachwald 2003) and studies by Eom and Lee (2010) and Fernández López et al. (2014) showed that the relationship between belonging to a group and university-industry cooperation is insignificant.

The age of the firm is argued to be related to university-industry cooperation. Cohen et al. (2002) argued that public research is more likely used by younger firms (start-ups) and their empirical results also support these suggestions. However, it has to be noted that in the sample used by Cohen et al. (2002) there were only 22 start-ups. Cardamone and Pupo (2015) stated that young firms tend to cooperate with universities more because they depend on scientific knowledge for technological innovation more. Studying five European countries revealed a significant relationship between the firm's age and university-industry cooperation only in Germany and Italy (Cardamone and Pupo 2015). Empirical findings from Bellucci and Pennacchio (2014) also showed a positive and significant relationship between being small and young and cooperating with universities. At the same time, Tether (2002), Laursen and Salter (2004), Volpi (2014) found no relationship between the firm's age and its cooperation with universities. Cardamone and Pupo (2015) provided an explanation for older firms to cooperate with universities as well: on the one hand, older firms have more experience and probably also a wider set of linkages, which makes cooperating with universities easier, on the other hand, older firms have gathered a larger amount of knowledge over time and might not need knowledge from universities.

The sector that the firm is active in is seen as a proxy to technological opportunity (Tether 2002). Tether (2002) looked at high, medium and low technology manufacturing sectors and high and low technology services. His results showed that firms from high-tech manufacturing are more likely to cooperate with universities, the low-tech services dummy had a negative relationship with university-industry cooperation while medium-tech manufacturing and high-tech services were insignificant. Mohnen and Hoareau (2003) distinguished between scientific and traditional sectors and found scientific sectors to be more likely to cooperate with universities. Segarra-Blasco and Arauzo-Carod (2008) followed the classification by the OECD (2006) and divided firms into four groups based on the sector (manufacturing vs services) and technological intensity (high- vs medium- and low-tech sectors), their results revealed that firms from both high-tech manufacturing and high-tech services are more likely to cooperate with universities. Miotti and Sachwald (2003) also followed the OECD classification, but their findings were contradictory to the findings of Segarra-Blasco and Arauzo-Carod (2008). Miotti and Sachwald (2003) showed that firms from high-tech sectors cooperate less with universities, compared to low-tech industries. Busom and Fernándes-Ribas (2008) used five industry dummies based on the technological level of the firm, which formed four groups and the fifth group was for the chemical and pharmaceutical industry. They assumed that in sectors where basic and applied research is important for innovating, firms were more likely to cooperate with universities. Empirical findings of

Busom and Fernándes-Ribas (2008) indicated that firms belonging to the chemical and pharmaceutical industry were more likely to cooperate with universities, but other dummies reflecting the technological level of the firm were insignificant. Similarly to other studies discussed above, Bellucci and Pennacchio (2014) divided firms based on their technological level using two dummies: one for high-tech manufacturing and the other for knowledge intensive services, both of which were found to be positive and significant. In a study by Cardamone and Pupo (2015), a high-tech dummy was used to distinguish between the technological levels of firms, as a result of which a positive relationship between belonging to high-tech industries and university-industry cooperation was found only for Italian data (in France, Spain, Germany and the UK, this relationship was insignificant).

As discussed in the previous chapter, for acquiring and exploiting external knowledge, firms need to have a certain level of absorptive capacity (Cohen and Levinthal 1990). In the case of universities as cooperation partners, absorptive capacity is believed to be a more critical precondition for cooperation compared to other cooperation partners such as customers and suppliers (Busom and Fernándes-Ribas 2008). Firms conducting R&D activities more intensively are more likely to cooperate with universities as the providers of basic research (Mohnen and Hoareau 2003) and scientific developments (Fontana et al. 2006).

In studies on university-industry cooperation, absorptive capacity is often studied through firms' R&D activities (for example with the share of R&D expenditures from sales in Mohnen and Hoareau 2003, Laursen and Salter 2004, Eom and Lee 2010, Bellucci and Penacchio 2014, Cardamone and Pupo 2015; with R&D employment in Fontana et al. 2006; with a dummy variable indicating whether a firm has conducted R&D activities in Tether 2002, Miotti and Sachwald 2003, Segarra-Blasco and Arauzo-Carod 2008, Tether and Tajar 2008, Volpi 2014). Busom and Fernándes-Ribas (2008) used five different measures to capture the knowledge capital of the firm, including indicators about patent applications (only in Spain or both in Spain and internationally), regular R&D activities, the ratio of R&D employees to non-R&D employees and the salary of R&D employees.

Empirical findings on R&D activities as one of the determinants of university-industry cooperation suggest that R&D activities (regardless of the measurement of R&D indicators) are positively related to university-industry cooperation, with two exceptions: studies by Mohnen and Hoareau (2003) and Eom and Lee (2010) did not find a significant relationship between R&D activities and cooperation. In the research by Busom and Fernándes-Ribas (2008), two out of five knowledge capital measures mentioned above turned out to be significant and positive, these are the ratio of R&D employees and patenting both in Spain and in international patent offices.

In addition to R&D, other innovation activities as possible determinants of university-industry cooperation have been studied in previous empirical papers as well. According to the Oslo Manual (2005), these activities include the acquisition of external knowledge (i.e. "rights to use patents and non-patented

inventions, trademarks, know-how and other types of knowledge" (OECD 2005: 98), acquisition of machinery and equipment and training. In empirical studies, the following "other" innovation activities were used: non-R&D innovation expenditures (Mohnen and Hoareau 2003), non-R&D innovation intensity (Capron and Cincera 2003), acquisition of external knowledge (Volpi 2014), acquisition of machinery and equipment (Volpi 2014), training (Volpi 2014, Guimón and Salazar 2014). From these activities, external knowledge was found to be significantly and positively related to university-industry cooperation on UK data (Volpi 2014). Guimón and Salazar (2014) showed based on Spanish data that training expenditures had a positive relationship with university-industry cooperation.

Another determinant of university-industry cooperation found in the literature is the "openness" of the firm. The main idea behind "openness" is related to the concept of open innovation (Chesbrough 2003) where "open" search strategies reflect the wide use of external knowledge sources (Laursen and Salter 2004). Laursen and Salter (2004) found openness to be a significant determinant of university-industry cooperation. Their study of British manufacturing firms revealed that the more external knowledge sources a firm had (which indicates the openness of the firm), the more likely it was to cooperate with universities. Following the research of Laursen and Salter (2004), Fontana et al. (2006) used three indicators to measure the openness of a firm: searching, screening, and signalling. Results by Fontana et al. (2006) based on seven European countries gave contradictory results compared to Laursen and Salter (2004): the searching variable used by Fontana et al. (2006) was insignificant while Laursen and Salter (2004) found a positive relationship between a firm's search strategy and university-industry cooperation. Screening and signalling (also measuring openness) were positive and significant in Fontana et al. (2006).

Similarly to Laursen and Salter (2004), Bellucci and Pennacchio (2014) used the number of types of cooperation partners and found it to be positively related to university-industry cooperation. Also Guimón and Salazar (2014) investigated the importance of having other cooperation partners (besides universities) and found that having other cooperation partners (measured with a dummy) is positively related to cooperating with universities.

The internationalisation of firms can also be seen as a determinant of university-industry cooperation. One variable measuring internationalisation is exporting. Exporters are facing stronger international competition, therefore the need for external knowledge and cooperation partners is higher (Busom and Fernándes-Ribas 2008, Carboni 2013, Cardamone and Pupo 2015). Exporting firms can be seen as firms with a higher level of capabilities. Therefore, similarly to larger firms, they have more resources for cooperating with universities. Empirical literature provides somewhat mixed results on that topic: Busom and Fernándes-Ribas (2008) used export intensity as a share of export in total sales, while Carboni (2013) used an exporting dummy; neither of these studies, the first on Spanish and the second on Italian data, found exporting and cooperating with universities to be related. Studies by Bellucci and Pennacchio (2014),

Volpi (2014) and Cardamone and Pupo (2015) showed a positive and significant relationship between exporting and cooperating with universities.

Another variable indicating the level of internationalisation is foreign ownership. Again, the reasoning used in the case of firm size, belonging to an enterprise group and exporting can be used for explaining the relation between foreign ownership and university-industry cooperation: both arguments are related to internal resources and internal knowledge sources apply (for knowledge flows within a multinational firm, see, for example, Gupta and Govindarajan 1991, Bresman et al. 1999, Birkinshaw et al. 2010). In addition, it is easier for foreign-owned firms to engage in collaborations due to their better reputation (Tether 2002). Therefore, it is assumed that such firms are more likely to have universities as cooperation partners. Reputation can be seen as a factor being more related to the university perspective, whether universities are likely to cooperate more with firms that have better reputation.

Another aspect that can determine the choice of cooperation partners in a foreign-owned firm is the subsidiary mandate (Rugman and Douglas 1986, Roth and Morrison 1992, Birkinshaw 1996). The subsidiary mandate determines the responsibilities of a subsidiary, which in turn affects cooperating with a university as well. On the one hand, a foreign-owned firm might not need the knowledge from a local university because there are other knowledge sources available within the firm (Tether 2002), which may include foreign universities as well. On the other hand, the subsidiary might not have the "right" (Birkinshaw and Hood 1998) to cooperate with local universities as the knowledge sources are regulated by the parent firm.

Busom and Fernándes-Ribas (2008) argued that patterns of cooperation concerning foreign-owned firms may differ by host countries, for example depending on the quality of local universities. Fu and Li (2016) found that foreign universities are chosen as cooperation partners in case the research capabilities of local universities are not aligned with the demand for knowledge on the firm's side. Also Laursen et al. (2011) argued that firms prefer research quality over geographical proximity when choosing a university as a cooperation partner. A paper by Hewitt-Dundas et al. (2017) studied the trade-off between utility and accessibility when cooperating with universities. Utility reflects the value of external knowledge and accessibility indicates the geographical proximity. It has to be noted that utility is a subjective aspect and is dependent on the internal knowledge of the firm, meaning that the value of external knowledge is related to the existing knowledge and absorptive capacity.

Boschma (2005) looked at proximity in a wider sense (not only geographical proximity) and stated that proximity might be negatively related to innovation activities due to the strong network failure (Jacobsson and Johnson 2000). This means the lack of openness (Boschma 2005) resulting in new partners that could be more useful for a firm in terms of knowledge transfer not being searched for and the firm cooperating with partners that are closer (in terms of geographical proximity).

The quality of local universities might be lower compared to foreign universities, but accessing knowledge from a local source requires fewer financial resources (is cost-effective) and is easier (Hewitt-Dundas et al. 2017) and thus might be the determining factor when choosing between local and foreign universities.

Another argument for searching for foreign universities pointed out by Fu and Li (2016) was that firms operate in different fields and local universities might not be able to provide all kinds of specific knowledge, even if they are high quality universities in advanced economies. Findings by Monjon and Waelbroeck (2003) showed that new types of academic knowledge are acquired from foreign universities.

Empirical results by Busom and Fernándes-Ribas (2008) based on Spanish manufacturing firms showed no significant relationship between foreign ownership and university-industry cooperation. Using a more recent sample of Spanish firms (both firms from the manufacturing and service sectors), the results by Segarra-Blasco and Arauzo-Carod (2008) were in line with the findings provided by Busom and Fernándes-Ribas (2008): foreign ownership is not significantly related to university-industry cooperation when cooperating with some other partners such as customers and suppliers or competitors, foreign ownership turned out to be a significant and positive factor.

Finding the right knowledge sources and engaging in cooperation can be costly for a firm (Cozzarin 2008); therefore, financial support from the central government or from the EU might be an important determinant of university-industry cooperation. In addition, in some support measures, cooperating with universities is stated as mandatory and cooperating with universities can therefore be seen as an opportunity to get access to funding (Mohnen and Hoareau 2003, Seppo et al. 2014, Guimón and Salazar 2014). In the case of financial support, empirical results are straightforward: financial support either from the government or from the EU is positively related to university-industry cooperation (Mohnen and Hoareau 2003, Capron and Cincera 2003, Miotti and Sachwald 2003, Busom and Fernándes-Ribas 2008, Segarra-Blasco and Arauzo-Carod 2008, Eom and Lee 2010, Guimón and Salazar 2014 and Cardamone and Pupo 2015).

There are many variables describing the characteristics of a firm included in previous literature; however, the results of different countries indicate that different determinants are significant for university-industry cooperation and some empirical papers have presented contradictory results on the direction of the relationship between a determinant and university-industry cooperation. When discussing the results of the studies, it has to be taken into account that in most of the research, only one country was analysed. Therefore, the comparison of the determinants of cooperation between countries is not straightforward because different studies use a different set of variables, which can affect the results (a variable can be significant in the model, but including additional variables might erase the significance of that particular variable, thus the results gained with different sets of variables must be compared with caution). There

are not only differences in the sets of variables, but differences in the used datasets and their timeframe exist as well. These aspects are also likely to have an impact on the results and their comparability.

In addition to different determinants used in the studies, also different sectors are included, which again makes the comparison of the results more difficult. The methods for gaining the results also vary in different studies and this can affect the results as well.

The previous studies discussed in this sub-chapter give a valuable insight into understanding the determinants of university-industry cooperation, but the need for a different study design to straightforwardly compare the results across several countries remains, thus this gap will be addressed in Study 1. Another issue not discussed yet is related to the comparative view in terms of the different background settings of the countries, meaning, for example, the income level of a country, the quality of their research institutions and the efficiency of their legal framework. All these settings can also be related to the determinants of university-industry cooperation, but these cannot be addressed while analysing one country at a time. The gap concerning including the background settings into the analysis of university-industry cooperation determinants is also addressed in Study 1.

Chapter 1.5 will provide an overview of all the research questions answered by this thesis and the research gaps addressed in terms of each of the questions.

1.4. The role of education in the innovation system

This chapter is devoted to discussing the importance of education in the innovation system. As mentioned in the Motivation section of this thesis, the value of the university as a knowledge source comes from education and research. Teaching and doing research are the core missions of universities, which are strongly related to the third mission of universities – contributing to the development of society. A recent concept showing the interrelations of the three missions of the university (education, research and innovation) is the knowledge triangle described in Chapter 1.1. Even though education as a part of the innovation system is also discussed, for example in Freeman (1987), the concept of the knowledge triangle (Sjoer et al. 2016, Unger and Polt 2017) focuses more on the activity aspect inside the innovation system.

Increasing the level of education in turn increases the level of absorptive capacity, which is a significant factor in university-industry cooperation (see Chapter 1.3 about the determinants of university-industry cooperation). More educated individuals are also more aware of available internal and external knowledge sources and are better able to recognise possibilities to gain new knowledge and might find universities to be a useful source of knowledge (see Chapter 1.2 about the knowledge search of a firm). As discussed in Chapter 1.3, providing the necessary knowledge and level of skills to students so that it would be in line with the need of other parties in the innovation system

(including firms) can be thought of as one possible way of university-industry cooperation. The education provided by the universities has also an impact on the activity level of graduates in terms of entrepreneurship and whether the graduates choose the opportunity driven direction afterwards. Therefore, giving an overview of the role of education in the innovation system is helpful in the context of the current thesis to build the theoretical background for studying university-industry cooperation.

According to the endogenous growth theory, human capital is the factor that explains the differences in economic growth (Lucas 1988), among knowledge (Romer 1986) and innovation (Grossman and Helpman 1991, Aghion and Howitt 1992). As stated by Becker (1994: 17): "[e]ducation and training are the most important investments in human capital." One possibility to increase the level of firms' human capital, is to hire more employees with a higher level of education (Skaggs and Youndt 2004, Dakhli and De Clercq 2004).

Human capital is seen as a significant factor of economic growth and innovation through several channels. With higher level of human capital, the level of absorptive capacity is increasing (Bartel and Lichtenberg 1987, Cohen and Levinthal 1990, Benhabib and Spiegel 1994, Barro 2001). In Nelson (1964), it was described that educated people are an important factor in the development process of a firm because they are complementary to other production factors. This is related to absorptive capacity (Cohen and Levinthal 1990), the firm's ability to exploit new technologies depending on the prior knowledge that the firm has – knowledge that is gained both from the on-the-job training and from universities (and other schools) as education providers. Formal education is seen as one of the determinants of absorptive capacity (Vinding 2006). Adopting new technologies is related to the creativity and flexibility of the employees, therefore starting to use new technologies, introduces some new requirements to the employees and education is a helpful measure for coping with these changes and adjusting to these requirements more easily (Wozniak 1984). The risk level of adopting new technologies is smaller for more educated people and at the same time, the benefits as a result of adopting the new technology are more likely to be higher (Nelson and Phelps 1966).

It is argued that human capital increases productivity (see, for example, Romer 1990, Rauch 1993, Benhabib and Spiegel 1994, Moretti 2003, Shapiro 2006, Vandenbussche et al. 2006) through an increased level of knowledge and skills. Knowledge as a part of human capital is seen as a continuous competitive advantage (Nonaka 2007) and the development of human resources, including the education level being the key element for increasing the knowledge base (Kim 2004). Compared to physical capital, it is harder for competitors to obtain the same level of human capital (Barro 2001) and this will give an advantage to the firm.

Education is said to enhance the ability "to receive, decode, and understand information, and that information processing and interpretation is important for performing or learning" (Nelson and Phelps 1966: 69), which makes education a significant input for innovation (Souitaris 2002a, 2002b). Nelson and Phelps

(1966) hypothesise in their paper that education increases the speed of technological innovation and can therefore be seen as the basis for innovation. Their hypothesis was proved in their study on the example of agriculture, but it can be generalised to other sectors as well because of the general reasoning behind this example. Nelson and Phelps (1966) argued that having a higher level of education allows to understand and evaluate the information provided better, for example by public institutions (including higher education institutions), journals, customers, and other companies. Better educated personnel are also more aware of the sources for getting information that is helpful for evaluating the possible outcomes of innovations (Wozniak 1984). This in turn enables to make grounded decisions about whether to adopt new technologies or not (Wozniak 1984).

Based on Smith et al. (2005: 348): "[e]ducation helps individuals improve their understanding of what they know, more accurately predict outcomes, better manage time and resources, and monitor results. In effect, education provides new explicit information and knowledge that greatly influence an individual's cognitive reasoning skills". Wiersema and Batel (1992) studied the relationship between the characteristics of top management and strategic changes in the firm. They found that characteristics such as a high educational level and technical specialisation are related to the receptivity to change and the willingness to take risks; in addition, they are also more aware of the need for changes (Wiersema and Batel 1992). This comes from the fact that they are able to evaluate new opportunities better, also in terms of possible uncertainties (Nelson and Phelps 1966, Skaggs and Youndt 2004).

In addition to before mentioned advantages that education is accompanied by, it also provides new ways to analyse problems (Becker 1994), think creatively, figure out new solutions (Skaggs and Youndt 2004) and increases the ability to discover new opportunities (Shane and Venkatraman 2000). More educated employees also think in a more systematic way and have an increased ability to "conceptualize the results" (Wozniak 1984).

The value of education has been on the rise in time due to the changes in the structure of industries, especially in skill-intensive industries (Welch 1970) and due to using more scientific knowledge in production (Becker 1994) and for innovation. The higher the level of technological progress in the economy, the more beneficial the education is (Nelson and Phelps 1966) and also the motivation for getting higher education is related to the level of technological change (Welch 1970). The higher level of salaries of highly educated individuals (i.e. the skill premium) is also raising the value of education (Mincer 1958, Krusell et al. 2000).

As it was seen based on previous literature, both the theoretical and empirical studies found a positive relationship between education and innovation. These afore mentioned studies indicate that in addition to the fact that education is directly related to a firm's performance and innovation activities, it is also indirectly in interaction with other firm level variables related to the indicators of the innovation activities of a firm.

A specific type of education – entrepreneurship education – has gained much attention because it can be seen as a possible driver of economic growth through increasing the intensions to become an entrepreneur and to increase the level of success and quality of the ones that become entrepreneurs (Matlay 2008, Raposo and do Paço 2011, Rauch and Hulsink 2015). As stated in Raposo and do Paço (2011: 453): "[e]ntrepreneurs drive innovation: they speed up structural changes in the economy and force old incumbent companies to shape up thereby making an indirect contribution to productivity." Therefore, it is important to understand whether the currently low number of entrepreneurs in Europe could be increased by providing a suitable education (both on the curriculum level in terms of subjects taught and the way of teaching them).

Research on entrepreneurship education is mainly divided into two parts: one part discusses how entrepreneurship is taught at universities, meaning studying the didactics and pedagogy. The second part concentrates on "how university relates to its context", covering the models of the "triple helix" and the term "entrepreneurial university". (Blenker et al. 2008)

Usually, these two areas of research are separated but this thesis discusses both of the parts of these research streams. First, the discussion will focus on the evolving of the university over time (see Chapter 1.1). Secondly, the thesis will cover the aspect of teaching; specifically, two different approaches to teaching entrepreneurship – the traditional way compared to the experiential entrepreneurship education (discussed in the current chapter). Combining these two fields of literature forms the basis for creating the framework for studying entrepreneurship education and is also a guideline for universities to cope with the changes of becoming an entrepreneurial university (Blenker et al. 2008).

As shown by the report of the Global Entrepreneurship Monitor (2018), the level of total early-stage entrepreneurial activity (TEA) is low in general and the lowest in Europe (being 8.1%). There is a growing trend in TEA, but the measures to increase the level are still searched for. It is believed that one way to increase the level of entrepreneurship to teach entrepreneurship in the first place (the question of which subjects to teach) and to teach it in a way (the question of how to teach it) that it would increase students' intentions to become an entrepreneur and not only their intentions, but them actually becoming an entrepreneur.

The objective of entrepreneurship education is to provide students with enterprising competencies so that they would be capable of discovering new opportunities and starting their own businesses or contributing to already existing ones by developing them and helping them grow (QAA 2018). The delivery of these competencies calls for approaches to teaching that would be the most suitable for creating these competencies.

To understand whether entrepreneurship education is fulfilling its aims, there are several papers studying the differences in the learning outcomes between entrepreneurship and non-entrepreneurship education. The following discussion will give an overview of these studies.

Unger et al. (2011) provided a meta-analysis based on the literature about the research on human capital and entrepreneurship. Based on their analysis, it can be said that human capital is the prerequisite for entrepreneurial success due to many arguments, e.g. human capital increases the capability to discover and exploit new business opportunities (Shane and Venkatraman 2000), human capital is the basis for learning and acquiring new knowledge and skills (Hunter 1986). Also, Raposo and do Paço (2011), Martin et al. (2013) found a positive relationship between entrepreneurship education and entrepreneurship outcomes based on a meta-analysis.

In Dickson et al. (2008), the relationship between education and entrepreneurial intentions and success is discussed, distinguishing between general and entrepreneurship education. Again, based on previous literature, the authors concluded that both general education and specific entrepreneurship education are positively related to entrepreneurial success. In addition, entrepreneurship education is related to the intentions of becoming an entrepreneur (Dickson et al. 2008).

Several papers have found positive relationship between entrepreneurship education and entrepreneurial intentions, for example Charney and Libecap (2000), Noel (2002), Küttim et al. (2014), Fayolle and Gailly (2015), Rauch and Hulsink (2015). Rauch and Hulsink (2015) found that these intentions mediate the relationship between entrepreneurship education and actually becoming an entrepreneur. At the same time, there are papers that found the relationship between entrepreneurship education and intentions to become an entrepreneur to be negative (von Graevenitz et al. 2010, Oosterbeek et al. 2010, Fayolle and Gailly 2015). Walter and Block (2016) suggested that these differences stem from the differences in the institutional environment. The importance of the environment in terms of the national systems of entrepreneurship is for example discussed in Acs et al. (2018). In the case of the paper by Fayolle and Gailly (2015), the differences come from previous entrepreneurial exposure.

In addition, positive relationship between entrepreneurship education and attitudes towards entrepreneurship (Fayolle and Gailly 2015), the perception of entrepreneurship (Stamboulis and Barlas 2014), entrepreneurial self-efficacy (Shinnar et al. 2014), the probability of starting a firm and higher entrepreneurial incomes (Elert et al. 2015) are found in the literature.

The results of entrepreneurship education are gaining importance, because creating new companies and new areas of business activities reflect the innovativeness of a community and are seen as the key drivers of economic growth. An important hampering factor of this kind of economic growth is the lack of entrepreneurial behaviour (Rasmussen and Sørheim 2006).

As it was seen from previous literature comparing entrepreneurship and non-entrepreneurship education, most of the studies find a positive relationship between entrepreneurship education and its outcomes. Still, the need for entrepreneurial behaviour is higher and everyone with the intentions of becoming an entrepreneur do not actually become one. This has brought about the discussion in the literature of entrepreneurship education about how entrepreneurship is

being taught and whether changes in the way of teaching can result in a higher level of actually becoming an entrepreneur (Gibb 2002, Jones and English 2004).

This is also in the focus of Study 3 where the objective is to analyse whether different teaching approaches (namely the traditional and experiential approaches) result in different levels of learning outcomes that are reflected by the students' cognitive, skill-based and affective outcomes in terms of entrepreneurial skills and attitudes.

Blenker et al. (2008) drew attention to the pedagogical approach of entrepreneurship education and argued that teaching should be in accordance with the objectives of this type of education and also the target group has to be taken into account when deciding about the teaching methods appropriate for entrepreneurship education. They also stated that the traditional teaching methods that are widely used in universities might not be the most suitable ones for teaching entrepreneurship (Blenker et al. 2008). The traditional way of teaching entrepreneurship is often equated with the education about entrepreneurship which is the opposite of the education for entrepreneurship (Levie 1999, Gibb 2002). It is believed that experiential, action-centred entrepreneurship education provides a better set of skills and behaviours that are necessary for being an entrepreneur and is therefore more suitable for teaching entrepreneurship (Fiet 2001, Jones and English 2004, Löbler 2006, Rasmussen and Sørheim 2006, Krueger 2007, Higgins and Elliott 2011). How to teach entrepreneurship so that it results in innovation is discussed for example in Baumol (2005).

At the same time, there is lack of empirical papers studying the difference between the learning outcomes of traditional and experiential entrepreneurship education. Previously mentioned papers about the action-centred entrepreneurship education mainly provide a theoretical reasoning for using action-centred education or the descriptions of case studies which use these action-centred teaching approaches, but do not empirically compare the results of the attitudes towards entrepreneurship, knowledge about entrepreneurship and entrepreneurial skills of traditional and experiential entrepreneurship education. The aim of Study 3 is to provide these empirical results based on Latvian business schools.

This chapter gave an overview of the importance of education and specifically entrepreneurship education in the innovation system and thereby provided the linkages between Study 3 and the other parts of the thesis. As the need for entrepreneurial behaviour is increasing in society and there is a lack of individuals taking part in entrepreneurial activities, the necessity to understand/evaluate the outcomes of different types of teaching entrepreneurship to better adapt the teaching programmes to the needs of society becomes more important. Study 3 of the current thesis uses a single country example to provide some insights into the different teaching approaches and the differences in the levels of learning outcomes gained through these approaches while filling a major gap in the entrepreneurship education literature.

1.5. Research questions

This thesis focuses on university-industry cooperation from three different angles, studying the determinants of university-industry cooperation, mapping the profile of a firm that cooperates with universities, which in turn gives insights into the second area of this thesis related to the governmental support measures for university-industry cooperation. The third line of study in this thesis is related to the entrepreneurship education that is provided by the universities. Taking all three fields of study together, this thesis touches upon the three main parts of the national innovation system: the firms reflecting the industrial system, universities as a part of the education and research system and support measures as a part of the political system (see Figure 3). As already discussed, national innovation itself is not in the focus of the thesis, but is used as a framework that connects the three parties of university-industry cooperation.

This chapter is devoted to giving a detailed overview of the research questions related to the three studies of this thesis. The first block of research questions is discussed in Study 1 and is related to the topic of the determinants of university-industry cooperation. As pointed out in the introduction of the thesis, one of the gaps in the recent literature on university-industry cooperation is the lack of a comparative view because most of the empirical studies are based on single country data or use pooled data. In Study 1, results from 14 different European countries are compared, which gives an opportunity to provide a comparative view. Using data from 14 European countries also makes it possible to address another research gap discussed in the introduction, namely the lack of relating the development indicators (for example the income level of the country, the quality of research institutions, the efficiency of the legal framework) to the inter-country differences in the case of the determinants of university-industry cooperation. Another issue addressed in Study 1 is the difference between cooperation determinants across domestic and foreign universities. Based on the research gaps, the following research question is stated and answered in Study 1: Which of a firm's characteristics are related to university-industry cooperation in different European countries?

Under the first research question, several characteristics of a firm pointed out in the literature review are studied, forming sub-questions to the first research question (see the full list of research sub-questions in Appendix 3). Altogether, five groups of characteristics of a firm are tested, including indicators reflecting firm size in terms of turnover, belonging to an enterprise group and having a higher number of employees (more than 50) while simultaneously being a part of an enterprise group. The second group of variables measure different innovation activities conducted by the firm (e.g. in-house R&D, external R&D, engagement in acquiring machinery and equipment, engagement in purchasing external knowledge in terms of inventions and know-how, conducting training for employees). The third group of variables indicates the degree of the firms' internationalisation in terms of both exporting and foreign ownership. The

fourth group of variables consists of only one indicator that reflects the number of the types of other cooperation partners except for the university, and the fifth group is related to financial support. Support from the government and support from the EU are the two measures under the financial support group.

The significance of all the mentioned variables is controlled separately for domestic and foreign universities, which is another gap in the recent literature that is being addressed by this thesis (specifically in Study 1).

Concerning the gap related to the lack of a comparative view, the research questions above are tested separately for all 14 European countries. In order to give a reasoning for the differences among the countries, these countries were divided into groups based on the variables reflecting development (forming country groups is described in Chapter 1.6) and the aim of Study 1 is to find differences in the determinants of university-industry cooperation across different background settings, i.e. across country groups.

Study 2 focuses on a different party of university-industry cooperation and the second research question is related to governmental support measures directed at university-industry cooperation. The second research question is: How is university-industry cooperation supported by governmental measures across different European countries?

For each of the measures directed at supporting university-industry cooperation, several aspects were studied, such as the eligibility of the university/firms to apply for the measure, whether cooperating with universities was set as a mandatory requirement for applying for the measure, who has to co-finance, which provides a detailed overview of the measures directed at university-industry cooperation. The aim of Study 2 is to identify patterns of governmental support measures across European countries. Similarly to Study 1, for identifying patterns the analysed countries were divided into groups using cluster analysis. The variables used for cluster analysis measure university-industry cooperation in terms of co-publications, higher education R&D expenditures (HERD) financed by the business sector, the extent of cooperation was also measured with data from the CIS questionnaire and the study of European university-business cooperation by Davey et al. (2011). For a detailed overview of the data and methods used in different studies, see Chapter 1.6. Dividing countries into groups enables to relate differences in the extent of cooperation to the different types of measures used in European countries.

In Study 3, the main focus is on the third part of university-industry cooperation – education and the research system; specifically, the type of education that universities provide and how it is related to the individual level of attitudes towards entrepreneurship, knowledge about entrepreneurship and entrepreneurial skills. One of the main gaps that Study 3 addresses concerning the research in the entrepreneurship education field is the lack of empirical testing of experiential entrepreneurial education resulting in a higher level of learning outcomes compared to traditional entrepreneurship education.

Therefore, the third research question is the following: Is the teaching approach implemented in the university/study programme related to the level of learning outcomes (human capital) created during the study period?

The level of the created human capital is measured by variables constructed with confirmatory factor analysis (see Study 3 for a detailed overview of the process of structural equation modelling) and reflects three types of learning outcomes: the cognitive, skill-based and affective outcomes. By teaching approaches experiential and traditional entrepreneurship education are meant. Sub-questions related to the specific learning outcomes are stated to address the research gap: whether experiential entrepreneurship education is related to a higher level of cognitive/skill-based/affective learning outcomes.

To summarise the chapter of research questions, it can be said that each of the studies included in the thesis is devoted to a different part of university-industry cooperation, whereas each of the studies looks at university-industry cooperation from a different angle.

1.6. Data and methods used in the thesis

This chapter gives an overview of the data and methods used in Studies 1–3. Each of the three studies use different databases as the main source of data. While Study 1 and Study 2 are based on secondary data, Study 3 is built upon primary data, collected by Inna Kozlinska (one of the authors of Study 3). For data and methods used in the studies, see Table 2.

For Study 1, the CIS questionnaire was the main data source, covering firm-level information about innovation activities for 16 European countries, thus data aggregated to the country-level was available for more than 16 European countries. Due to the missing data, 14 European countries out of the 16 available were used and Norway together with Ireland was left out of the firm-level analysis. In addition, Study 1 also uses information from the European Innovation Scoreboard and Global Competitiveness Report.

For providing answers to the first research question (see Chapter 1.5 for an overview of research questions and Appendix 3 for the list of sub-questions addressed in Study 1) and testing the significance of the possible determinants of university-industry cooperation, regression analysis was used in Study 1. Regression analysis was based on the CIS questionnaire, for an overview of the variables used in the econometric models, see Table 3. The choice of variables was driven by the determinants used in previous studies. In addition, to keep the models of different countries comparable, variables that were available for all the countries were included in the models, meaning that some of the variables that could be related to the probability of cooperating with universities, e.g. belonging to a high-technology sector, were left out of the analysis. Logit regression was used to estimate the results. In the case of university-industry cooperation (as an event), the share of non-events in the data set might be high; therefore, also logistic regression for rare events data (relogit) was used (for an overview about

logistic regression in rare events data, see King and Zeng 2001). Regular logistic regression and logistic regression for rare event gave similar results. Therefore, estimations from regular logistic regression are presented in Study 1.

Table 2. Data and methods used in Studies 1–3

Study	Method	Data
Study 1	Regression analysis Cluster analysis	CIS data for 14 European countries (provided by Eurostat), altogether 45,566 observations (firm-level data), covering innovation activities for the period of 2006–2008 Additional data from European Innovation Scoreboard (2010), Global Competitiveness Report (2008–2009), Eurostat (2017)
Study 2	Cluster analysis Analysis of variance	Inventory of Research and Innovation Policy Measures provided by Erawatch and INNO-Policy TrendChart, data used for 23 European countries Additional data from Eurostat, Innovation Union Scoreboard (2011), study of the State of European University-Business Cooperation (Davey et al. 2011)
Study 3	Structural equation modelling (SEM) Analysis of covariance Content analysis Semi-structured interviews	Data concerning recent graduates and final year students were gathered via an online survey between March and May 2013, 306 responses (Kozlinska 2016) Data concerning entrepreneurship educators were gathered through semi-structured interviews between April and October 2012, 8 educators were interviewed (Kozlinska 2016)

Source: based on Studies 1–3.

Table 3. Variables used for regression analysis in Study 1

	Variable	Description	Expected relation	Explanation of the expectation
Dependent variable	**University-industry cooperation**	dummy – takes value 1 if the firm has used a university as a cooperation partner		
Size indicators	**Log(turnover)**	logarithm of turnover	+	Larger firms have more internal resources to cooperate with universities and are more likely aware of the capabilities of universities (Tether 2002)
	Enterprise group	dummy – takes value 1 for belonging and 0 for not belonging to an enterprise group	+/-	Country specific, depending on the quality of knowledge sources available, especially universities as a possible knowledge source
	Size[7]*Enterprise group	dummy – takes value 1 in case of larger enterprises belonging to an enterprise group and 0 in all other cases	+/-	Country specific, depending on the quality of knowledge sources available, especially universities as a possible knowledge source
Innovation activities	**In-house R&D**	dummy – takes value 1 if the firm is conducting this type of activities and 0 for not conducting	+	Innovation activities (especially conducting R&D) are a way to increase firms' absorptive capacity, which in turn is helping to use knowledge from external sources, including universities (Cohen and Levinthal 1990)
	External R&D			
	Machinery[8]			
	External knowledge[9]			
	Training			

[7] Due to the heterogeneous set of European countries, only two size groups are considered because some smaller European countries do not have three size groups available. The two size groups are the following: small enterprises with less than 50 employees and larger enterprises with more than 50 employees.

[8] The acquisition of advanced machinery, equipment and computer hardware or software (Eurostat).

[9] The purchasing or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other organisations (Eurostat).

Table 3 (continued). Variables used for regression analysis in Study 1

	Variable	Description	Expected relation	Explanation of the expectation
Inter-nationali-sation	**Exporting**	dummy – takes value 1 if the firm has sold something outside of its own country	+	International competition leads to the necessity to cooperate more (Busom and Fernándes-Ribas 2008)
	Foreign owned	dummy – takes value 1 if the firm has a foreign head office	+	Foreign owned firms have more resources to cooperate with universities
Cooperation partners	**Different partners**	the number of the firm's other types of cooperation partners excluding universities, with a maximum value of 5	+	The higher number of other types of cooperation partners a firm has, the more likely it is to have a university as one of the cooperation partners (Laursen and Salter 2004)
Funding	**Funding from the state**	dummy – takes value 1 if the firm has received that type of financing	+	When an enterprise is receiving support for innovation activities, it is more likely to have resources for cooperating with universities (Mohnen and Hoareau 2003)
	Funding from the EU		+	
Industry	**Services**	dummy – takes value 1 if the firm belongs to the service sector	+/-	Country specific, depending on the industries included in the sample

Source: based on Study 1.

Besides the CIS questionnaire, data from other sources (the European Innovation Scoreboard and Global Competitiveness Report) were used for the background settings of countries to form country groups. Country groups were formed using cluster analysis for a better interpretation of the results of the econometric analysis. For variables used as background settings, see Table 4. The complete linkage method[10] and the Euclidean distance as a measure of dissimilarity were applied to conduct the analysis, all variables were standardised before the analysis. The value of the Duda and Hart index was the basis for deciding the number of clusters to be used in the final model.

Similarly to Study 1, Study 2 is also based on secondary data, the main database used is the Inventory of Research and Innovation Policy Measures. This database provides detailed information about countries' policy measures in terms of different programmes/measures, their financing, details about applying for these measures, their starting and ending dates, policy priorities related to them. Information from this database is used to answer the second research question: How is university-industry cooperation supported by governmental measures across different European countries?

To fulfil the aim of Study 2 and to make finding patterns of the measures supporting university-industry cooperation easier, cluster analysis was applied. For the cluster analysis, the following variables were used (see Table 5): the sum of R&D related cooperation measures evaluated by HEIs (from Davey et al. 2011), the share of firms cooperating with universities (from Eurostat, based on the CIS questionnaire[11]), public-private co-publications (from the Innovation Union Scoreboard) and HERD financed by the business sector (from Eurostat).

Similarly to Study 1, the Euclidean distance was used as a dissimilarity measure in Study 2. Using different linkage methods did not change the main results, the final results in Study 2 are based on the single linkage method and all the variables were standardised before the analysis. The value of the Duda and Hart index was the basis for deciding the number of clusters to be used in the final model.

The European University–Business Cooperation study includes, among other research methods, data gathered through an online survey covering 33 countries, which were used in this thesis. The respondents of this survey were academics and higher education institutions' (HEIs) representatives.

[10] Other linkage methods (for example single linkage and average linkage) were used to control for the robustness of the cluster analysis, with the result that using different linkage methods does not change the main outcome of the cluster analysis.

[11] It has to be noted that in the CIS questionnaire, only technologically innovative (conducting product or process innovation) firms were asked about different cooperation partners.

Table 4. Variables used for cluster analysis in Study 1

Variable	Measured with	Time period	Source of data
Income level of countries	GDP per capita in purchasing power parities	For the year 2008	Eurostat
Business sector R&D financed by the government	% of GDP	For the years 2008–2009	Eurostat
Efficiency of the legal framework[12]	Likert scale from 1 to 7 (1 = in-efficient and subject to manipulation, 7 = efficient and follows a clear, neutral process)	For the years 2008–2009	Global Competitiveness Report
Corruption[13]	Likert scale from 1 to 7 (1 = is common, 7 = never occurs)	For the years 2008–2009	Global Competitiveness Report
Quality of scientific research	Likert scale from 1 to 7 (1 = non-existent, 7 = the best in their fields internationally)	For the years 2008–2009	Global Competitiveness Report
Summary Innovation Index	A composite indicator summarising 25 innovation performance indicators	For the year 2009	European Innovation Scoreboard

Source: based on Study 1.

The representatives from HEIs had to evaluate the extent of the cooperation on a scale from 1 to 10 where 1 indicates no cooperation at all and 10 shows the highest extent of cooperation. Altogether, eight different channels for university-industry cooperation were evaluated (for the full list of cooperation channels, see Davey et al. 2011). In Study 2, two of these were analysed, the chosen fields of cooperation were those related to R&D activities (collaboration in R&D and the commercialisation of R&D results). Data from the Inventory of Research and Innovation Policy Measures are limited to policy measures from the field of innovation and R&D, therefore other cooperation channels were not included in Study 2.

[12] Measures the capacity of private businesses to settle disputes and challenge the legality of government actions and/or regulations.

[13] The diversion of public funds to companies, individuals, or groups as a result of corruption.

Table 5. Variables used in the cluster analysis in Study 2

Variable	Measured with	Time period	Source of data
Collaboration in R&D	Scale from 1 to 10 (1 = no collaboration at all, 10 = high extent of collaboration)	For the years 2010–2011	Davey et al. (2011)
Commercialisation of R&D results	Scale from 1 to 10 (1 = no commercialisation at all, 10 = high extent of commercialisation)	For the years 2010–2011	Davey et al. (2011)
Share of co-operators	The share of technologically innovative firms who use a university as a cooperation partner	For the years 2006–2008	The CIS questionnaire, Eurostat
Public-private co-publications	The number of public-private co-publications per million population	For the year 2011	Innovation Union Scoreboard
HERD by business sector	Higher education R&D expenditures financed by the business sector, % of GDP	For the year 2012	Eurostat

Source: based on Study 2.

Study 3 differs from Studies 1 and 2 in terms of data sources, since it uses primary data. Data were collected from recent graduates and final year students of four Latvian business schools, which were included in the online survey that was carried out between March and May 2013 by Inna Kozlinska. The respondents were studying on the bachelor's level (or had graduated a programme recently) on entrepreneurship-related programmes. Eight entrepreneurship educators from the same Latvian business schools were interviewed, semi-structured interviews were carried out between April and October 2012 by Inna Kozlinska. Information from the interviews was used to identify the underlying method of teaching entrepreneurship education (traditional vs experiential) by content analysis.

Answers from the graduates collected via the online survey were used to compose a model measuring three learning outcomes: cognitive, skill-based and affective outcome. Confirmatory factor analysis as the first step of structural equation modelling (hereinafter SEM) was used to build the measurement model describing the three different learning outcomes. During the purification process, questions with lower loadings were removed and the validity and reliability of the constructs (and between the constructs) were controlled with average variance extracted (AVE) as the measure for convergent validity, with the composite reliability indicator (ρ) and discriminant validity. After achieving a good model fit and the required level of validity and reliability measures, factor scores for each learning outcome were calculated to be used in the following analysis. As the second step of SEM, structural model was built. The factor scores were used to test the relationship between the applied teaching approach and the three learning outcomes (cognitive, skill-based and affective).

For testing the hypotheses, three separate models for each of the learning outcomes were estimated.

Testing the relationship can be divided into three parts, starting from the analysis of variance where the teaching approach is the only explanatory variable in the model, Bonferroni post-hoc tests were used for a pairwise group comparison. In the second and third part of the hypotheses testing, several co-variates and other control variables were added to the model and therefore, analysis of co-variance was used. Among the co-variates, prior knowledge about entrepreneurship (in the model of cognitive outcomes), prior experience in entrepreneurship, prior work experience (in the model of skill-based outcomes), and prior entrepreneurship career aspirations (in the model of affective outcomes) were used. In the second step, prior competences were used as a co-variate and additional control variables including having a parent-entrepreneur, the gender of the respondent, attitudes towards educators, and the status of being a graduate or undergraduate were used in the model.

This chapter summarised the data and methods used in studies 1–3. Data and methods were chosen so that it would enable answering the research questions stated in each of the studies.

2. EMPIRICAL STUDIES

3. DISCUSSION OF RESULTS AND CONCLUSIONS

3.1. Empirical findings and discussion

In this chapter, the empirical findings providing answers to the research questions stated in Chapter 1.5 are presented. As described in Chapter 1.5, the three studies included in the thesis are all focusing on a different party of university-industry cooperation and study university-industry cooperation from three different perspectives: from the firm side, providing insights into which firms cooperate with universities across 14 European countries; from the governmental side, describing different settings for university-industry cooperation measures in 23 European countries; and from the university side, concerning the creation of human capital through graduates. Therefore, the empirical findings are structured according to the three studies.

The first research question was: Which of a firm's characteristics are related to university-industry cooperation? As pointed out in the section of research questions, these characteristics are studied across 14 European countries (Bulgaria, the Czech Republic, Cyprus, Estonia, Germany, Hungary, Italy, Latvia, Lithuania, Portugal, Romania, Slovakia, Slovenia, Spain). At the same time, separate results are provided for domestic and foreign universities as cooperation partners. In addition to these dimensions, also indicators reflecting the development including the income level of the country, the quality of the research institutions, and the efficiency of the legal framework of the countries were included in the analysis.

Under the first research question, several sub-questions concerning the determinants of university-industry cooperation were stated (see Appendix 3 for the list of research questions of Study 1), all of which were controlled with regression analysis.

In order to make the comparison of 14 countries easier, cluster analysis was used to group the countries. As a result of the cluster analysis, four clusters (country groups) formed. Germany differs from the other countries by its development indicators and therefore formed a separate group (it has to be noted that the sample of countries is biased towards Central and Eastern European countries. For a detailed overview of the limitations, see Chapter 3.3). The second group consists of countries that can be called countries with a high income and a well-functioning innovation system, namely Cyprus, Estonia, Portugal, Spain, and Slovenia. In the following group, the average income level of the countries is lower compared to the first and second groups and also, the innovation system is functioning moderately. The Czech Republic, Hungary and Italy are countries that form the third group. The fourth group of countries consists of Lithuania, Latvia, Slovakia, Bulgaria and Romania and it can be described by a middle income and a rather weak innovation system.

The results of all the research sub-questions are discussed based on country groups mentioned above. The first sub-questions are related to the size of the firm. As pointed out in Chapter 1.3, there are different empirical findings about

the relationship between firm size and the probability to cooperate with universities. Concerning the relationship between the firm size and university-industry cooperation in the current thesis, size in terms of turnover does not matter and larger firms do not cooperate more with foreign universities compared to smaller firms (when other firm characteristics are controlled for). These results are interesting because in most of the previous studies conducted on European data, firm size was found to have a positive relationship with university-industry cooperation. The reason why size was not a significant factor can be that the necessary capability level to cooperate with universities is not related to the turnover of the firm but is related to some other factors.

The country group consisting of the Czech Republic, Hungary and Italy is the only country group where in the case of all the countries, turnover is positively and significantly related to the propensity to cooperate with universities (for the Czech Republic this holds for cooperating with foreign universities, for Hungary and Italy it is the case for cooperating with domestic universities). This is the country group where the average level of turnover is the lowest compared to the other country groups. This might be the case of capabilities' failure where the firms with a lower turnover are less likely to cooperate with universities because cooperating requires additional financial resources. For country groups with a higher level of average turnover (three other country groups), turnover is not related to cooperating with universities, which indicates that both smaller and larger firms in terms of turnover are able to cooperate with universities.

While size measured with turnover was found to have a positive relationship with university-industry cooperation in the literature, belonging to a group is seen rather as an inhibiting factor for cooperating with universities. The results of the thesis show that firms belonging to an enterprise group are less likely to cooperate with universities, especially in case of cooperating with domestic universities, which might reflect the lower quality of the knowledge provided by domestic universities. At the same time, it must be noted that there is no prevailing positive relationship between belonging to a group and cooperating with foreign universities either. Therefore, the other reasoning behind the negative relationship between belonging to a group and cooperating with universities can be that different parts of the group itself are used as knowledge sources and there is no need for university knowledge as discussed in the literature (for example in Tether 2002).

While the results concerning belonging to an enterprise group are straightforward in the thesis, empirical findings from the literature give mixed results. A negative relationship (as in the current thesis) was also found by Mohnen and Hoareau (2003) on pooled data on Germany, France, Ireland and Spain, and by Miotti and Sachwald (2003) on French data. A positive relationship between belonging to an enterprise group and cooperating with the university has been found in data for the UK (Tether 2002) and Spain (Segarra-Blasco and Arauzo-Carod 2008). In the literature, explanations for both of the directions of the relationship are provided. On the one hand, firms belonging to a group have access to knowledge sources inside the group and might not need external

knowledge; on the other hand, being a part of a group makes finding the right partner easier due to networks (Mohnen and Hoareau 2003), knowledge pooling (Tether 2002) and resources (Miotti and Sachwald 2003).

As the third size indicator, the combination of being large in terms of the number of employees (a firm was considered to be large if the number of employees was 50 or more) and belonging to a group was used. Similarly to other size indicators, it did not prove to be significant in the model for domestic universities for any of the countries and had contradictory results in the case of foreign universities where one positive and one negative relationship was found based on 14 countries. It is interesting that size is not significant and the significance of size is not related to the development indicators of the country, meaning that for firms operating in different national innovation systems, size is not the determinant of university-industry cooperation, with the exception of the group of the Czech Republic, Hungary and Italy.

The second set of variables used in the model was related to innovation activities. From the CIS questionnaire, several innovation activities were included and tested separately in the thesis. Based on the literature, firms conducting innovation activities are more likely to cooperate with universities (Tether 2002, Miotti and Sachwald 2003, Laursen and Salter 2004, Fontana et al. 2006, Segarra-Blasco and Arauzo-Carod 2008, Busom and Fernándes-Ribas 2008, Tether and Tajar 2008, Volpi 2014, Bellucci and Penacchio 2014, Cardamone and Pupo 2015). The results of the thesis reveal that the relationship between innovation activities and university-industry cooperation depends on the innovation activities the firm is conducting. This means that just being engaged in innovation activities is not a precondition for university-industry cooperation. These results are somewhat contradictory compared to previous studies that mostly found a positive relationship between innovation activities and university-industry cooperation or in some cases, the relationship was insignificant but a negative relationship as found in this thesis did not occur in the analysed literature.

While firms conducting in-house R&D (as a measure of absorptive capacity) and external R&D are more likely to cooperate with universities, firms acquiring machinery and equipment are less likely to cooperate with universities. This might be due to the fact that firms conducting R&D activities need other types of knowledge compared to firms engaged in acquiring machinery and equipment. Therefore, university knowledge could be considered to be more suitable for R&D activities and those acquiring machinery can find the necessary knowledge from some other sources, e.g. from suppliers.

To sum up the results concerning the innovation activities, it can be said that in-house R&D is seen as a significant determinant for cooperating with domestic and foreign universities both, while external R&D is significant mainly in cooperating with domestic universities. However, external R&D can be seen as a supportive determinant in the case of foreign universities as well, but not in as many countries as in the case of domestic universities. These results are in line with the literature about absorptive capacity that has been emphasised by Cohen and Levinthal (1990) and has been empirically tested by several studies, for

example by Mohnen and Hoareau (2003), Laursen and Salter (2004), Cardamone and Pupo (2015). Somewhat interesting is the result that in-house R&D is related to cooperating with domestic universities in 11 countries and in the case of foreign universities, in-house R&D is significant in eight countries. Contradictory results would have been expected by the author of the thesis because cooperating with foreign universities requires more resources, including knowledge. This in turn may indicate that it is easier for a firm to cooperate with domestic universities due to better knowledge about the cooperation partner. It is more likely that firms have better knowledge about local universities compared to foreign universities and also the willingness of universities to cooperate with a firm might depend on their knowledge available about the firm. Depending on the host country, the quality level of foreign universities might be higher and therefore, a higher level of absorptive capacity from the firm's side is needed (cooperating with foreign universities might require a different type of absorptive capacity). In many studies, R&D is used as a proxy for absorptive capacity; therefore, it was expected for R&D activities to be more significant for cooperating with foreign universities.

Firms acquiring machinery and equipment are less likely to cooperate with universities, this holds both in the case of domestic and foreign universities.

Being engaged in purchasing inventions and know-how gives mixed results and seems to be country-specific in the case of cooperating with universities. Despite the location of the university, both negative and positive relationships between engaging in these activities and cooperating with universities are found in the thesis. No country group differences are present in the case of external knowledge. The results are similar concerning engaging in training where there is also no clear trend whether firms engaging in training are more or less likely to cooperate with universities, again both negative and positive relationships can be found. Differences in the direction of the relationship (also in case of other determinants of university-industry cooperation) can be the result of country-specific context (Johns 2006), which in turn emphasises the importance of studying the background settings of the countries.

Given the results related to innovation activities, it can be summarised that being engaged in innovating activities does not necessarily lead to cooperating with universities, but the nature of these innovation activities is important. Therefore, it can be concluded that the indicators reflecting a firm's own absorptive capacity, such as in-house R&D, are more likely to be related to cooperating with universities and activities that reflect obtaining knowledge outside the firm, e.g. acquiring machinery, equipment, external knowledge, training, have a negative relationship with university-industry cooperation (for some exceptions of a positive relationship, see Study 1 for detailed results).

The third group of variables is included to control for the degree of internationalisation as a supporting factor of cooperation. By internationalisation, exporting and foreign ownership are meant. Results concerning exporting suggest that being an exporter is significantly related to cooperating with universities, especially in the case of foreign universities. The reason for

exporters to be more likely to cooperate with universities lies within the global competition that they are facing and hence the need for university knowledge for innovating is seen as more important compared to non-exporters. Co-operating with foreign universities while entering foreign markets also seems to be a valid point. On the one hand, in terms of competing abroad, the knowledge from abroad (including foreign universities) may be more helpful and up to date based on the current market situation (for example the technological level) compared to knowledge from local universities. Due to the limitations of Study 1, it was not possible to control whether the firm was exporting to the same country where the foreign university as a cooperation partner was located. On the other hand, the firms that are exporting have experience with communicating with partners abroad and it might be easier for them to cooperate with foreign universities, compared to non-exporters that do not have experience with partners abroad. According to Fu and Li (2016), foreign universities are chosen in case local universities do not provide the necessary knowledge for the firm. This suggests that in addition and due to the global competition, local universities are not able to provide the knowledge that is needed by exporting firms, because of the lack of the necessary research capabilities. This might be the case for Central and Eastern European countries where the quality of the research of local universities may be lower compared to the quality of foreign universities.

In the case of the second internationalisation indicator – foreign ownership, the relation with cooperating with universities depends on the location of the university. For cooperating with foreign universities, foreign ownership can be seen as a supportive determinant, but foreign-owned firms are less likely to co-operate with domestic universities. This might be related to similar reasons as highlighted for belonging to an enterprise group: firms with the owner abroad might not find the knowledge from local universities to be useful, instead cooperating with customers, competitors, suppliers can give an insight into the new markets and make the operating in another country easier while knowledge for technological innovation activities can be found inside the firm (Gupta and Govindarajan 1991, Bresman et al. 1999, Birkinshaw et al. 2010) or from foreign universities (where also the headquarters of the firm is located). Busom and Fernándes-Ribas (2008) also argued that cooperation with local universities depends on the quality of these universities and is therefore host country specific.

Studying internationalisation reveals differences between country groups. It was concluded earlier that foreign owned firms are more likely to cooperate with foreign universities, this holds in the case of countries with a stronger (compared to other countries in the sample) innovation system, for instance Germany, Cyprus and Portugal. At the same time, foreign-owned firms were less likely to cooperate with domestic universities, this statement founds support in countries with a stronger innovation system, with the exception of Slovakia. The results show that in countries with weaker innovation systems foreign

ownership as a cooperation determinant for domestic or for foreign universities is insignificant, with the exception of Slovakia.

Differences between country groups also emerge in the case of exporting. In the country group with a moderately functioning innovation system (consisting of the Czech Republic, Hungary and Italy), exporting is not related to the probability of cooperating with domestic universities in none of these countries, but is a significant supporting factor for cooperating with foreign universities in all three countries in this group. This might be due to the lack of research capabilities of the universities located in these countries (especially in Central and Eastern European countries as the Czech Republic and Hungary) and therefore, firms have to look for partners abroad to find knowledge that is necessary to compete on global markets. In other words, local universities are not able to provide sufficient knowledge to exporting firms, which makes it more likely for the firm to cooperate with foreign universities.

The number of other types of cooperation partners is highly significant and positive in all the countries and both for cooperating with domestic and foreign universities. This result is related to the openness hypothesis discussed in the literature from the viewpoint of "open innovation" (Chesbrough 2003). By openness, the wide use of external knowledge sources is meant (Laursen and Salter 2004). Openness can be measured with the breadth and depth of the search as discussed by Katila and Ahuja (2002), Laursen and Salter (2006). In the current thesis, the breadth of the search is included in the analysis (measured by the different types of cooperation partners that a firm has). The significance of openness in cooperating with universities has found support in the following empirical studies: Laursen and Salter (2004), Bellucci and Pennacchio (2014), Guimón and Salazar (2014). Being open also means being able to use knowledge from external sources and a certain level of absorptive capacity (Cohen and Levinthal 1990) is a precondition for that, meaning that the openness of the firm is related to the firm's absorptive capacity as well. This could also be a reason why absorptive capacity itself (measured by R&D activities) is not significant for all the countries while the number of different types of cooperation partners is highly significant for all the countries and both for cooperating with domestic and foreign universities.

Two research questions were stated about external financial support, the government and the EU as the sources of financial support were controlled for. It turned out that financial support from the governmental side is related to a higher probability of cooperating with universities, especially domestic universities. Also, support from the EU is revealed to be a determinant of university-industry cooperation, both for cooperating with domestic and foreign universities.

On the one hand, financial support can be seen as a measure to overcome the lack of financial resources needed for cooperating with universities (Busom and Fernándes-Ribas 2008); on the other hand, cooperating with universities is seen as a way to access funding, because in some measures cooperating with universities is set as a mandatory requirement (Mohnen and Hoareau 2003, Seppo et al. 2014, Guimón and Salazar 2014).

Similarly to Study 1, previous empirical papers have also found a positive relationship between financial support either from the central government or from the EU and university-industry cooperation (Mohnen and Hoareau 2003, Capron and Cincera 2003, Miotti and Sachwald 2003, Busom and Fernándes-Ribas 2008, Segarra-Blasco and Arauzo-Carod 2008, Eom and Lee 2010, Guimón and Salazar 2014 and Cardamone and Pupo 2015).

Differences between country groups are related to the financing from the EU where in countries with a weaker innovation system the EU financing is not related to the probability of cooperating with universities, while in countries having a better performing innovation system the EU financing is a significant determinant.

This might come from the fact that in countries with better performing innovation systems, the other preconditions (including the infrastructure) for cooperating with universities are better (i.e. the background settings support the cooperation) and then the financial support from the government or from the EU helps to overcome the lack of financial resources for cooperating with universities. In countries with a weaker innovation system, the other conditions for cooperation might be less supportive and then the additional financial support for cooperating does not play a significant role in cooperation, but there are other factor that are related to the probability to cooperate.

Another reason can come from the set-up of the supporting measures, whether the cooperation is set as mandatory while applying for the support for cooperation. Based on Study 2, it can be seen that in countries with a weaker innovation system, such as Lithuania, Latvia, Romania and Slovakia, the share of measures with optional cooperation is higher compared to other countries.

As seen from the discussion of empirical results, the determinants of university-industry cooperation are dependent on the location of the university (cooperating with domestic vs foreign universities) and additionally also on the development indicators of the analysed country (differences between country groups).

To sum up the empirical findings of Study 1, it can be said that they provide a valuable input for designing policy measures directed at university-industry cooperation. Knowing which type of firms cooperate with universities can be helpful in several ways. On the one hand, firms that are less likely to cooperate with universities, for example firms that do not conduct in-house R&D and those who do not export, could be directed towards universities through targeting this type of firms with policy measures to bring them together with universities. On the other hand, if there is knowledge about what types of firms cooperate with universities, it is possible to target the potential cooperators with policy measures (policy measures for the non-cooperator type and the cooperator type should be different) because they might have a higher probability to cooperate with universities, but have not done it so far. Still, it has to be kept in mind that Study 1 has its limitations (for an overview of limitations in the three studies used in the thesis, see Chapter 3.3) and the determinants discussed in Study 1 are relevant for firms that are technologically innovative and the

determinants of university-industry cooperation could be different for non-innovating or not technologically innovative firms (firms conducting organisational and marketing innovation), compared to technologically innovative firms.

The determinants (that are characteristic to firms that cooperate with universities) found in Study 1 may give an indication about system failures related to university-industry cooperation which keep firms from cooperating with universities. For example, there are characteristics that determine cooperation with domestic universities, but the same characteristics are not related to cooperating with foreign universities (e.g. financing by the state). This might be related to institutional failure. The framework of regulations and the legal system are designed in a way that it is in favour of cooperating with domestic rather than with foreign universities.

Differences in the determinants of cooperating with domestic and foreign universities can also indicate both transition and network failures. In case of transition failure, firm capabilities are not on the necessary level to absorb a new type of knowledge and hence also not sufficient for cooperating with foreign universities which demands more resources compared to cooperating with domestic universities. More resources are needed in terms of finances to find a partner abroad, a different kind of absorptive capacity might be needed because the knowledge provided by foreign universities may differ from the knowledge gained from domestic universities. For finding a cooperation partner abroad, also contacts and networks are important.

Another failure indicated by this kind of cooperation (cooperating with domestic but not with foreign universities) might be related to network failure, both weak and strong. In case of weak network failure, it is hard to find a cooperation partner abroad due to the lack of linkages. In case of strong network failure, there are tight connections with domestic universities and therefore new knowledge sources are not searched for. Strong network failure applies in the case, where a firm has other cooperation partners and is therefore not looking for additional cooperation partners. Results from Study 1 show that on the one hand, having other type of cooperation partners is positively related to cooperating with universities, but on the other hand, belonging to an enterprise group and being foreign-owned, which include cooperating within the firm, are negatively related to cooperating with domestic universities.

To mitigate the network failures, there can be several measures that support the cooperation between university and industry. For example, there is a measure called Innovation voucher, which is common in European countries (Schade and Grigore 2009, OECD 2011). This measure is meant for small and medium-sized enterprises for cooperating with public knowledge providers, including universities (OECD 2011, Enterprise Estonia 2018). This measure helps to create the initial cooperation between university and industry and thereby reduce the network failures. At the same time, this measure helps to overcome possible financial constraints hampering the cooperation between university and industry.

Another block of measures mitigating the network failures is related to creating clusters (Porter 1998, OECD 1999, Cooke 2001, Engel 2015). Clusters are meant to support cooperation between different actors of the innovation system, including firms and universities (Enterprise Estonia 2018). Some of the European countries were engaged in a project "Smarter Cluster Policies for South East Europe" with an objective of "to enhance the capacity of regional policy makers to confront, prevent and anticipate change, developing smart specialization strategies for cluster improvement" (ClusterPoliSEE 2018). Descriptions of different programmes supporting clusters can also be found from "Competitive Regional Clusters: National Policy Approaches" (OECD 2007), where programmes of 14 OECD countries are included. Activities related to creating clusters are important tools to improve the transfer of knowledge, also between university and industry (Cooke 2001, Engel 2015), thereby also mitigating the network failures.

There are also other reasons for cooperating with domestic and not with foreign universities that are not related to system failures. It can be that for a firm there is no need for knowledge from foreign universities and all the necessary knowledge is gained from domestic universities and from other cooperation partners.

In addition, there are other characteristics that are related to system failures as well, for example the size of the firm. Larger firms are more likely to have a higher level of capabilities. Therefore, it would be expected that larger firms are more likely to cooperate with universities. The results from Study 1 show that size in terms of turnover was significant only in the country group, which had the lowest average level of turnover. This may indicate the capabilities' failure that firms with a lower turnover are not able to cooperate with universities. At the same time, it was not the case in other country groups that had a significantly higher turnover. This might in turn indicate, that when there is a certain level of turnover, the size in terms of turnover does not matter, but in the case the turnover is at a lower level, differences between size groups exist. Here, the example of Innovation voucher can be used again. It is a measure meant specifically for small and medium-sized enterprises to overcome capabilities failures related to the size of the firm.

The second research question was: How is university-industry cooperation supported by governmental measures? In other words, how are country specific features of national innovation systems reflected in supporting university-industry cooperation? As discussed in Chapter 1.1, there are several system failures that occur within the national innovation system and are used to justify policy interventions. In the context of university-industry cooperation, some of the system failures might occur more frequently, namely infrastructural failure, failures related to capabilities (capabilities' failure, transition failure, learning failure), and networking failure (Metcalfe and Georghiou 1998, Smith 2000, Gustafsson and Autio 2011, García Manjón and Romero Merino 2012, Hewitt-Dundas et al. 2017). These failures can be seen as barriers to the cooperation and through providing a different type of policy measures, the government is

trying to reduce and mitigate these barriers. Both incentives to cooperate and barriers on cooperation can be influenced by policy-related framework conditions such as legislation and regulations, promotion programmes and institutional settings (Polt et al. 2001, Seppo et al. 2014).

Study 2 provides a detailed overview of different measures directed at university-industry cooperation in European countries. Due to the high number of countries included in the analysis (23 European countries were studied), cluster analysis was conducted to obtain a more generalisable result and fulfil the aim of Study 2 that was to identify the patterns of cooperation measures across countries. The cluster analysis was based on indicators measuring university-industry cooperation (see the list of variables in Chapter 1.6) and as a result, four country groups emerged. The Netherlands as a special case in terms of the supporting measures according to several indicators formed a separate group. All measures in the Netherlands require the university to be a mandatory cooperation partner, none of these measures are co-financed by the EU structural funds, and there are no measures only firms can apply for. The second group consisted of Nordic countries (Finland, Sweden, Denmark and Norway). Germany, Austria and Belgium belong to the third cluster and the fourth cluster is the largest with 14 European countries (France, Ireland, Spain, the Czech Republic, Hungary, Italy, Estonia, Romania, Portugal, Slovakia, Latvia, Bulgaria, Lithuania, and Poland).

The results of Study 2 reveal the heterogeneity of the measures across the European countries, which in turn reflect different ways of addressing system failures. All the university-industry cooperation measures are mitigating the capabilities' failure in terms of the lack of finances. However, results of Study 2 show that patterns in the differences in the supporting measures across the European countries can be seen in terms of the failure of financial capabilities (reflected by the requirements of co-financing). In most of the new member states of the EU, a large number of cooperation measures are co-financed by the EU, which reflects the failure of financial capabilities in these countries. For example, in Estonia all the measures directed at university-industry cooperation were co-financed by the EU or co-financed by a combination of the EU structural funds and the private sector. There were no measures in Estonia where the private sector was the only co-financer. In other new member states, the situation is similar: the share of measures co-financed by the private sector is low. This means that the problem of financial capabilities is more severe in the new member states of the EU compared to older member states where a high share of cooperation measures is co-financed by the private sector. The share of the private sector as a co-financer is the highest in Denmark, the Netherlands and Sweden, followed by Norway, Germany and Finland.

While looking at the variables reflecting the cooperation level of the countries (i.e. variables used for clustering), it can be seen that in the fourth cluster which is mainly formed by the new member states of the EU, the level of cooperation is the lowest for all the variables used for measuring cooperation. Cooperation was measured with the sum of R&D related cooperation measures

evaluated by HEIs, the share of firms cooperating with universities, public-private co-publications and HERD financed by the business sector. At the same time, cluster four can be described as the most dependent on the EU structural funds. This means that the requirements and focus of support measures are also derived from European structural funds. This makes the measures, and also the implementation of these measures, less flexible. Inflexibility (in terms of the bureaucratic implementation of programmes) in turn discourages both the universities and especially enterprises from using the support measures more effectively. This might be reflected by the lowest level of cooperation compared to other country groups.

The cluster of Nordic countries has the highest level of cooperation according to the CIS questionnaire. At the same time, the share of cooperation measures where cooperating with a university is set as a mandatory requirement is the highest. This could be due to the fact that through the initial mandatory requirement, initial contacts between universities and industry are established and this may transform into long-term cooperation. Establishing the initial connection between the university and industry helps to mitigate network failures in several ways. Firstly, it mitigates the weak network failure where firms do not have linkages with universities at all. Secondly, it raises the awareness of using universities as cooperation partners (if a firm has other types of linkages) or the awareness about other universities that could be used as a cooperation partner (if a firm is already cooperating with a university and is not looking for another university to cooperate with). This might be the case when a firm is cooperating with local universities and is not aware of foreign universities that could be a useful knowledge source. Raising the awareness of other universities as possible cooperation partners when a firm already has linkages with some universities is related to mitigating the strong network failure.

Another characteristic of the measures related to the mandatory/optional dimension is the eligible applicant. Country groups with the highest cooperation levels, both from the viewpoint of universities and firms, have the highest share of measures which require joint applications (the university and firm have to apply for the measure together). The county group consisting of Germany, Austria and Belgium has the highest level of cooperation according to the study conducted by Davey et al. (2011) where representatives of universities had to evaluate the extent of university-industry cooperation. In the country group consisting of Nordic countries, the level of cooperation according to the CIS questionnaire was the highest. In these country groups the share of joint applications was the highest.

If only the number of measures (and not the characteristics of the measures) is considered, it can be said that in the country groups where the number of measures is higher, the cooperation level is higher as well. Again, the two country groups mentioned in the previous paragraph are examples of a high number of cooperation measures and a high level of cooperation.

To sum up the results of Study 2, it can be said that countries with different background settings address failures arising within the national innovation

system in a different way. The results revealed that in countries with a higher level of cooperation, the measures directed at university-industry cooperation are designed in a different way compared to those in the new member states of the EU.

All the research questions in Study 3 are related to the learning outcomes and the broader definition of university-industry cooperation; specifically, whether the teaching approach is related to different attitudes towards entrepreneurship, knowledge about entrepreneurship and entrepreneurial skills. The results of Study 3 reveal that experiential entrepreneurship education is not always related to a higher level of learning outcomes. This holds in the case of all three learning outcomes: cognitive, skill-based and affective outcomes. The first step of the analysis was to build a measurement model for the three above mentioned outcomes based on the answers of the respondents. A confirmatory factor analysis (as described in Chapter 1.6 for Data and methods used in the thesis) was used to estimate the measurement model. The construct of the cognitive learning outcome consisted of questions related to entrepreneurship and management theories, the second construct – skill-based learning outcomes, was mainly formed from questions concerning interpersonal relationships. The affective learning outcome as the third measure of human capital included questions about the willingness to become an entrepreneur. For a detailed overview of the questions of the survey that were included under each of the learning outcomes after the purification process, see Study 3.

To sum up the findings from Study 3, it can be said that comparing different teaching approaches (traditional vs experiential entrepreneurship education) gave puzzling and unexpected results. These results might be related to the context of Latvia and using data for some other country might reveal differences between teaching approaches.

All the three studies included in the thesis reflect the importance of background settings, i.e. the context where the subject being studied is situated. In Study 1, it was seen that the determinants of university-industry cooperation vary across different innovation systems, in countries with strong innovation systems, such as Germany, Cyprus, Spain, Portugal, the most significant determinants were variables reflecting the level of internationalisation and EU funding. In countries with a less developed innovation system (e.g. Lithuania, Latvia, Bulgaria, Romania), the factors mentioned above are not important for university-industry cooperation. This is related to the context of the innovation system and how well the actors of the system are related to each other, how developed are the actors of the system, how the knowledge flow takes place/is organised between the activities inside the innovation system (education, research and innovation) and at which stage the universities are in terms of becoming entrepreneurial universities. As discussed in the literature, many universities in Europe are still struggling with the challenges of moving towards entrepreneurial universities and this is also an important determinant of the level of university-industry cooperation and is related to the characteristics of firms that are cooperating with universities.

In Study 2, again, the differences between countries come from the background settings. It can be seen that countries with a higher level of development (mostly older member states of the EU), have university-industry cooperation measures where the private sector contributes more to supporting the cooperation, compared to countries where a significant part of university-industry support measures are co-financed by the European structural funds (mainly new member states of the EU). The differences between the countries based on their development and the performance of their innovation systems can be found across other characteristics of support measures as well, for example the share of measures with mandatory cooperation. For each of the countries analysed, the level of the performance of the innovation system has an impact on the development of the support measures and as there are significant differences in the performance of the innovation systems (see, for example, the European Innovation Scoreboard for a comparison of a wide range of innovation indicators), there is also a high level of heterogeneity in the support measures between the European countries because the scope and the importance of system failures that each of the innovation system faces are different.

Similarly to the first two studies, also Study 3 shows the significance of the context. Although this study is not a comparison of several countries, still the interpretation of the results depends on the Latvian context. The main conclusion of Study 3 was that experiential and traditional entrepreneurship education do not result in different attitudes towards entrepreneurship, knowledge about entrepreneurship and entrepreneurial skills. This can be explained by several aspects. In a broader context, the weak entrepreneurial ecosystem and the infrastructure in Latvia might not provide a supportive environment for the differences of the learning outcomes to occur. The Expert Ratings of the National Entrepreneurial Framework (taken from the Global Entrepreneurship Monitor 2018) also show that in some areas, Latvia is below the average level of Europe, e.g. internal market dynamics, government policies in terms of taxes and bureaucracy, and R&D transfer.

The lack of difference between the learning outcomes may also be a result of a low level of students' readiness and preparation to learn in an experiential way because in most of the subjects the traditional way of teaching prevails in the methods applied and students are not used to the experiential approach. Another reason can be the pedagogical skills of the educators, which might be especially problematic in the case of practitioners teaching the subject. They have good experience in the field, but the way they pass on their knowledge and skills to the students might not results in a higher level of learning outcomes.

The current chapter gave an overview of the empirical findings from the three papers used in the thesis and also provided some discussion of the results. The following chapter draws conclusions.

3.2. Conclusions

The aim of this thesis was to study university-industry cooperation in the framework of the national innovation system while answering three different questions concerning university-industry cooperation, related to the firm, governmental and university sides of the national innovation system. These questions were associated with the determinants of university-industry cooperation, policy measures provided to support university-industry cooperation and knowledge created by the universities. These research questions were answered in three empirical studies, each of which was focused on a different party of university-industry cooperation. Study 1 was devoted to the firms' side, Study 2 had policy measures in its focus, and Study 3 emphasised the role of universities as creators of knowledge (human capital).

Over time, the roles of the participants of university-industry cooperation have changed. For example, universities have gained additional missions starting from teaching that was followed by research and now, contributing to the environment is seen as the third mission of universities (Etzkowitz and Webster 1998, Wissema 2009, Etzkowitz and Viale 2010). Changes in the roles of the participants are accompanied by the changes is the cooperation between the university and industry as well (Etzkowitz and Leydesdorff 1998). A well-known model describing university-industry cooperation is the model of the triple helix (Etzkowitz 1993, Etzkowitz and Leydesdorff 1995) where the roles of the university, industry and government overlap (Etzkowitz and Leydesdorff 2000, Etzkowitz 2003).

One of the recent concepts reflecting university-industry cooperation covering all three missions of universities (education, research and innovation) is the knowledge triangle (Sjoer et al. 2016, Unger and Polt 2017). Both the concepts of the national innovation system and the knowledge triangle were used as the main theoretical framework for studying university-industry cooperation in the thesis.

The results of the thesis revealed that the context of the innovation system plays a significant role in university-industry cooperation, no matter which part of the innovation system is under study (firms, the university or government).

The results showed that cooperating with universities depends on a large variety of determinants, including firm-level factors, for instance innovation activities, the degree of internationalisation, the openness of the firm. Yet, at the same time, there are many development indicators related to university-industry cooperation as well, for example the functioning of the national innovation system, the income level of the country. Study 1 provided input for designing policy measures directed at university-industry cooperation and also drew attention to possible system failures related to university-industry cooperation that are reflected by the characteristics of the firms cooperating (or not cooperating) with universities. Based on the characteristics, three types of system failures were recognised: institutional, capabilities' and network failures. Mitigating these failures is seen as a justification for policy interventions.

Study 1 described the profile of a firm that cooperates with universities, which is valuable input for designing policy measures. Depending on the type of measures and the aim/priority of the measure, both "potential" cooperators and non-cooperators can be targeted with measures directed at university-industry cooperation.

While providing the results discussed above, Study 1 addressed several research gaps, namely the lack of a comparative view of European countries in terms of the determinants of university-industry cooperation, the lack of comparing the determinants across the locations of the university (domestic vs foreign universities), and the lack of relating the development indicators of a country to the determinants of university-industry cooperation.

The results of Study 2 indicated that the design of policy measures directed at university-industry cooperation differ based on the performance of the national innovation system, which again reflects the importance of the context of the innovation system. In country groups with a higher level of university-industry cooperation, the share of measures with mandatory cooperation is higher, also the share of measures with a joint application is higher and these measures are mainly co-financed by the private sector. Study 2 provided an overview of differently designed measures for supporting university-industry cooperation and enables to learn from the experience of better performing countries. For example, in countries with a higher number of cooperation measures, the cooperation level is higher as well. Therefore, increasing the number of cooperation measures might result in an increase in the level of university-industry cooperation as well. Requiring mandatory cooperation seems to be a good practice because it creates initial linkages between firms and universities, which might be a good starting point for future cooperation. The gap in the knowledge filled with Study 2 is related to creating a detailed database of policy measures directed at supporting university-industry cooperation.

The results of Study 3 revealed that the teaching approach provided by the universities might not be related to the learning outcomes, but there are other factors related to the characteristics of the individual, such as gender, the occupation of the parents and prior knowledge and experience gained by this individual. At the same time, it has to be taken into account that the study was conducted based on Latvian business schools and is therefore related to the context of Latvia. This means that the lack of difference in the learning outcomes (while comparing the traditional and experiential teaching methods) might not come from the teaching methods but is related to the whole entrepreneurial ecosystem of Latvia and how it supports (or does not support) the use of experiential teaching methods.

These findings are useful for designing supporting measures directed at university-industry cooperation in a broader sense, in terms of how to support the creation of knowledge that is needed by society and specifically by industry, through designing study programmes that meet the needs the best. These measures may include supporting practitioners or researchers from abroad as guest lecturers, for example. The results of Study 3 give a good example that

prioritising one specific teaching approach might not necessarily result in higher learning outcomes, rather the subject taught and the entrepreneurial ecosystem that forms the (non-)supportive environment makes the difference.

3.3. Limitations and ideas for future research

The main theoretical concepts used in the thesis are limited to the concepts of the national innovation system and the knowledge triangle. The approach of the national innovation system is a well-established and widely used approach in the literature of innovation studies. At the same time, the approach of the innovation system has been criticized for being too general and "not specifying the boundaries of the systems" (Edquist 1997). There are also discussions, whether the systems of innovation is undertheorised (Fischer 2001) or over-theorised (Edquist 2006). This approach is considered to be difficult to use in policy making (OECD 2002, Chaminade and Edquist 2005).

The concept of the knowledge triangle can be criticized for being policy driven and there are not many analyses nor evaluations of the concept conducted by researchers (Lassnigg et al. 2016).

There are limitations concerning the data used in this thesis as well. In Study 1, the results of the regression analysis are based on the CIS questionnaire, which has its shortcomings. In the CIS questionnaire, only technologically innovative firms (firms engaged in product or process innovation) are required to answer a block of questions related to cooperation partners and knowledge sources, therefore firms engaged in other types of innovation activities do not answer questions about cooperation. This means that the sample of firms used in the analysis consists of technologically innovative firms and the determinants of cooperation found to be significant can be generalised only for such firms and not for firms conducting other types of innovation activities or for firms that are not engaged in any innovation activities. For all the 14 European countries analysed in Study 1, the methodology of the CIS questionnaire was the same, which makes comparing countries possible (European Commission 2012).

Another issue with the CIS questionnaire is that it is self-reporting in its nature (Galindo-Rueda and Van Cruysen 2016), meaning that the answers can be biased and might also depend on the respondents, which means that different persons from the same firm can evaluate the cooperation situation differently.

It has to be noted that due to the data availability, countries from Central and Eastern Europe form the majority of the countries included in the analysis of Study 1 due to their good data availability. It was already seen from the results of the cluster analysis that Germany formed a separate group as a country with a higher income level and a well-functioning innovation system, while other countries belonged to lower income level groups and their innovation systems were not functioning that well.

The methodology of the CIS questionnaire is similar in different European countries, which enables the inter-country comparison. However, there might be

some differences related to specific variables, for example data about the sector of the firms. For all the countries, there is information about the sector the firms operate in, but the aggregation level of those sectors is different for different countries (based on the firm-level data provided by Eurostat). Therefore, in Study 1, the authors were able to distinguish between the service and manufacturing sector, but were not able to differentiate the service and manufacturing sectors according to their technological level. It would have been possible for some countries, but not for all 14 countries and to keep the results of the regression analysis comparable between countries, the highest aggregation level was used for all the countries included in Study 1. For a discussion about the use and challenges of the data from innovation surveys, see, for example, Mairesse and Mohnen (2010), Bogliacino et al. (2012), Galindo-Rueda and Van Cruysen (2016), a workshop proceeding on the "Advancing Concepts and Models for Measuring Innovation" (2017). It has to be noted that in the other papers based on the CIS questionnaire (for example in papers listed in Appendix 2), the same shortcomings are present.

The fifth limitation is valid for Study 1 and does not come from the methodology of the CIS questionnaire but is related to the time-frame of the CIS questionnaire used in Study 1. While writing Study 1, the newest data available for the CIS questionnaire were for the period 2006–2008. It is a specific period in many ways: firstly, new member states of the EU started using the EU funds at that time and secondly, two countries analysed in Study 1 (Bulgaria and Romania) joined the EU in 2007. Thirdly, it is the period just before the economic recession.

Despite the list of the shortcomings in the CIS questionnaire, the survey provides both quantitative and qualitative data on several innovation activities on firm-level, at the same time, different types of innovations are included in the survey (Mairesse and Mohnen 2010). Due to the similar methodology in different European countries, the results of the survey are comparable across countries (Eurostat 2017). Another advantage of the CIS is that this questionnaire is compulsory for the countries and is conducted on a regular basis (Eurostat 2017). Due to the regularity and the information included in the survey, it provides a good possibility to monitor and to benchmark the innovation performance, both over time and across countries, which makes the survey a helpful tool for policy makers (Mairesse and Mohnen 2010).

For future research, it would be interesting to compare the determinants of university-industry cooperation over the economic cycle, there are data available for several waves of the CIS questionnaire that cover the whole economic cycle. This kind of study would give insights into what extent the economic environment is related to the determinants of university-industry cooperation. In Study 1, some indicators reflecting the development of countries were included in the analysis, but the economic environment can also play an important role concerning the determinants of cooperation in different countries. In future studies, it could be interesting to broaden the set of development variables to provide more reasoning for the inter-country differences in the determinants of

cooperation. Another research direction is related to the sectoral system of innovation which requires a sectoral level analysis that could be carried out based on the CIS questionnaire.

It has to be noted that the models in Study 1 are used for evaluating the correlative and not the causal relationship between the determinants of cooperation and the probability to cooperate with universities. These models suffer from endogeneity issues, meaning that the direction of the relationship between the dependent variable (university-industry cooperation) and the explanatory variables is not so straightforward. For example, firms conducting R&D activities are more likely to cooperate with universities, but it can be the other way around as well: firms cooperating with universities might be more likely to conduct R&D activities. Due to the cross-sectional nature of the community innovation survey, it is not possible to say which of the activities (cooperation or conducting R&D) preceded which.

Endogeneity can be caused by measurement errors in explanatory variables, omitted explanatory variables (for example the skills and education of employees in terms of university-industry cooperation), simultaneity, autoregressive models, and lagged dependent variables as one of the explanatory variables (Murray 2006, Angrist and Pischke 2009) and the "reflection problem" discussed by Manski (1993).

One possibility to mitigate the endogeneity issue is to use instrumental variables (see, for example, Kennedy 2003, Angrist and Pischke 2009, Wooldridge 2012), but finding the right instrumental variable is not an easy task; moreover, using weak or invalid instruments may be accompanied by inconsistencies and instrumental variable estimates may suffer from a bias (Bound et al. 1995, Staiger and Stock 1997, Stock and Yogo 2002).

As some of the data used in Study 2 come from the CIS questionnaire, most of the limitations of the CIS questionnaire described above also apply for Study 2, including the self-reporting issue. This is an issue for another data source used in Study 2 as well, namely the European study on university-business cooperation by Davey et al. (2011). While the CIS questionnaire has firms as self-reporters, the study by Davey et al. (2011) has university representatives as self-reporters. The main database used in Study 2 – the Inventory of Research and Innovation Policy Measures, includes measures related to research and innovation which means that research and innovation policies are analysed in Study 2. In addition, another limitation of Study 2 is the selection of cooperation measures: measures that stated university-industry cooperation as one of their aims were included in the analysis, other measures that could also support university-industry cooperation were excluded. It has to be noted that there are other activities led by the government that could support cooperation between universities and industry, not only support measures.

For future research, it would be interesting to add political and institutional settings to the analysis of different support measures as has been done in Study 1 for analysing the determinants of university-industry cooperation. As Study 1 revealed, there can be inter-country differences coming from the development

indicators of the analysed countries. In addition to the absolute number of the measures, it would be better to look at the budgets of these measures because there might be several small-budgeted measures in one country and a small number of larger measures in another country, resulting in the number of measures not being fully comparable between countries. In Study 2, the budgets of the measures were left out of the analysis due to many missing values and in the case of larger measures including several sub-measures, it was not clear which amount was directed at a specific activity under one measure. Another idea for future research is to use information about the impact of the measures. When Study 2 was written, many measures were ongoing and some ended too late to evaluate the impact of the measures, but at the moment, there is enough information about the evaluation of support measures provided by different country-based reports, making this kind of analysis possible.

Study 3 is based on individual level data that were collected by one of the authors of Study 3. It has to be noted that this study is solely based on data from graduates of four Latvian business schools and therefore, the results and conclusions might depend on the contextual framework of the Latvian education system and the whole entrepreneurial ecosystem. In addition, similarly to Study 1 and Study 2, also the self-reporting aspect arises as graduates had to evaluate the knowledge gained themselves.

For future research, a longitudinal study might be a good opportunity to evaluate the effect of a bachelor's level programme compared to the currently used cross-sectional survey where both prior knowledge and knowledge gained through the teaching programme had to be evaluated at the same time. Separating the prior and gained knowledge may cause some difficulties for the respondents, especially, when some time has passed from the graduation already. In addition, it would be interesting to see whether the conclusions of Study 3 hold for other countries as well or if they are specific to the Latvian context.

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APPENDICES

Appendix 1. Definitions of main terms used in the thesis

In terms of university-industry cooperation, both of the terms "university" and "industry" are used as general terms, not referring to any specific type of higher education institutions (in case of universities) nor to any specific sector in case of industry, rather referring to the business sector as a whole.

University

On the European level, higher education institutions are defined as "distinct organisations /…/ whose major activity is providing education on tertiary level (ISCED 2011 level 5, 6, 7 and/or 8)". In addition, these institutions must be "officially accredited", "have at least some level of autonomy /…/ and are able to strategically decide their focus concerning activities" and "have an internal organisational structure and, at least in principle, their own budget". (Lepori et al. 2017: 14–15) This definition follows the one provided by EUMIDA European University Data Collection.

Throughout the thesis, terms 'university' and 'higher education institution' (abbreviated as HEI in the thesis) are used as synonyms.

Cooperation

Throughout the thesis, the term 'cooperation' is used to describe the interaction between university and industry. In the literature, terms 'cooperation' and 'collaboration' are both used for describing the relationship between university and industry. However, these two terms are not synonyms and are distinguished (see for example Mattessich and Monsey 1992, Roschelle .and Teasley 1995, Polenske 2004, Thomson and Perry 2006, Schöttle et al. 2014 for a comparison of the characteristics of cooperation and collaboration based on previous research papers, whereas many of the characteristics come from Mattessich and Monsey 1992).

In case of collaboration, a common mission is shared between the parties, the relationship lasts longer (Mattessich and Monsey 1992), the level of integration is higher as is interaction, commitment and complexity (Thomson and Perry 2006), compared to cooperation.

According to Polenske (2004) cooperation relationships are defined as follows (p. 1031): "… two or more actors agree through formal or informal arrangements to share information, support managerial and technical training, supply capital, and/or provide market information. The relationships among these actors are usually external and horizontal, i.e. the actors do not work together on designing, producing and/or marketing a product (process)" Following Polenske's (2004) work, collaborative relationships need more time to be built compared to cooperative ones.

Taking into account the differences between terms ‘cooperation’ and ‘collaboration’, the term of ‘cooperation’ is used in the thesis, because in terms of the thesis, activities that do not require long-term relationship, high level of interaction, integration and commitment are considered, while discussing university-industry relationship, for example lifelong learning.

Appendix 2. Overview of the data used in empirical studies on university-industry cooperation determinants

Authors	Country	Sector	Method	Innovation survey
Tether (2002)	UK	M+S	Trivariate probit	CIS2 (1994–1996)
Mohnen and Hoareau (2003)	DE, FR, IR, ES	M	Ordered probit	CIS2 (1994–1996)
Capron and Cincera (2003)	BE	M	Ordered probit	CIS2 (1994–1996)
Miotti and Sachwald (2003)	FR	M	Logit	CIS2 (1994–1996)
Laursen, Salter (2004)	UK	M	Ordered logit	UK Innovation Survey covering 1998–2000
Fontana, Geuna and Matt (2006)	D, FR, GR, DE, IT, UK, NL	M+S	Logit, ZINB	KNOW survey (2002)
Busom and Fernándes-Ribas (2008)	ES	M	Probit	Spanish Innovation Survey (1996–1998)
Segarra-Blasco and Arauzo-Carod (2008)	ES	M+S	Logit	CIS3 (1998–2000)
Eom and Lee (2010)	K	M	Probit	Korean Innovation Survey (2000–2001)
Carboni (2013)	IT	M	Multi-variate probit	The Survey of Manufacturing Firms (2003)
Fernández López, Pérez Astray, Rodeiro Pazos, Calvo (2014)	ES, FR, PT	M+S	Probit	Project CREATINN for the years 2009–2012
Bellucci and Pennacchio (2014)	BG, CY, CZ, DE, IT, EE, ES, HU, LT, PT, LV, RO, SI, SK	M+S	Ordered logit	CIS2008 (2006–2008)
Guimón and Salazar (2014)	ES	M+S	Probit	CIS covering 2005–2011
Volpi (2014)	UK	M+S	Ordered probit	UK Innovation Survey 2009
Cardamone and Pupo (2015)	FR, DE, IT, ES, UK	M	Probit	Efige data covering 2007–2009

Note: In the column "Sector", M indicates the manufacturing sector and S stands for service sector. The key for country abbreviations: DE – Germany, CY – Cyprus, EE – Estonia, PT – Portugal, ES – Spain, SI – Slovenia, CZ – the Czech Republic, HU – Hungary, IT – Italy, LT – Lithuania, LV – Latvia, SK – Slovakia, BG – Bulgaria, RO – Romania, K – Korea, UK – the United Kingdom, GR – Greece, FR – France, BE – Belgium, D – Denmark, IR – Ireland, NL – the Netherlands. ZINB – zero inflated negative binomial.

Source: compiled by the author based on the studies listed in the table.

Appendix 3. The list of research questions addressed in Study 1

RP1.1: Larger firms are more likely to cooperate with universities
- RP1.1.1: Firms with a higher turnover are more likely to cooperate with universities
- RP1.1.2: Firms belonging to an enterprise group are more likely to cooperate with universities
- RP1.1.3: Firms that are larger and part of an enterprise group are more likely to cooperate with universities

RP1.2: Firms conducting innovation activities are more likely to cooperate with universities
- RP1.2.1: Firms conducting in-house R&D are more likely to cooperate with universities
- RP1.2.2: Firms conducting external R&D are more likely to cooperate with universities
- RP1.2.3: Firms engaged in acquiring machinery and equipment are more likely to cooperate with universities
- RP1.2.4: Firms engaged in purchasing external knowledge in terms of inventions and know-how are more likely to cooperate with universities
- RP1.2.5: Firms conducting training for employees are more likely to cooperate with universities

RP1.3: Firms with a higher degree of internationalisation are more likely to cooperate with universities
- RP1.3.1: Firms that export are more likely to cooperate with universities
- RP1.3.2: Firms that are foreign-owned are more likely to cooperate with universities

RP1.4: Firms having several types of cooperation partners are more likely to cooperate with universities

RP1.5: Firms getting external financial support are more likely to cooperate with universities
- RP1.5.1: Firms getting financial support from the government are more likely to cooperate with universities
- RP1.5.2: Firms getting financial support from the EU are more likely to cooperate with universities

SUMMARY IN ESTONIAN – KOKKUVÕTE

ETTEVÕTETE-ÜLIKOOLIDE KOOSTÖÖ RIIGI INNOVATIOONISÜSTEEMI KONTEKSTIS

Töö aktuaalsus

Ettevõtete-ülikoolide koostööle on läbi aegade palju tähelepanu pööratud, nii teadlaste kui poliitikakujundajate poolt, seda just teadmuse kui olulise arenguallika valguses. Globaliseeruvas maailmas kasvab ettevõtete vajadus välise teadmuse järele, et olla edukas innovatsioonitegevustes (von Hippel 1988, Chesbrough 2003, Chesbrough 2006) ja säilitada konkurentsieelis (Teece et al. 1997). Välist teadmust on võimalik saada erinevatest allikatest, sealhulgas tarbijatelt, tarnijatelt, konkurentidelt, nii avalikelt kui erasektori teadusasutustelt (Laursen ja Salter 2006, Leiponen ja Helfat 2010, Köhler et al. 2012, Laursen 2012).

Teadustööst tulenevat teadmust nähakse kui olulist sisendit tehnoloogilise arengu jaoks (Klevorick et al. 1995). Ka haridus läbi inimkapitali arendamise on oluline innovatsioonivedur (Nelson ja Phelps 1966, Smith et al. 2005). Seetõttu on ülikool oluliseks teadmusallikaks nii läbi teaduse kui hariduse. Teise akadeemilise revolutsiooni käigus muutus oluliseks ülikoolide kolmas missioon ehk ühiskonda panustamine.

Läbi järjepideva ettevõtete-ülikoolide koostöö uurimise on paranenud arusaam selle olemusest (Etzkowitz 1993, Etzkowitz ja Leydesdorff 1995, Etzkowitz ja Leydesdorff 2000, Etzkowitz 2003, Carayannis ja Campbell 2009). Üks uuemaid kontseptsioone, mis peegeldab ülikooli kolme missiooni ja selgitab nii teaduse kui hariduse olulisust innovatsiooni jaoks, on teadmuse kolmnurk (Sjoer et al. 2016, Unger ja Polt 2017). Kui riigi innovatsioonisüsteem keskendub erinevatele osapooltele ja nende vahelistele suhetele (Freeman 1987, Lundvall 1992), siis teadmuse kolmnurk rõhutab innovatsioonisüsteemis toimuvaid tegevusi (mitte tegijaid). Innovatsioonisüsteemi keskmes oleva innovaatilise ettevõtte toimimine sõltub ühest küljest ettevõtjate võimekusest ja kasutatavast tööjõust, mis on omakorda seotud haridus- ja teadussüsteemiga. Teisest küljest mängivad rolli aga taustatingimused (kontekst) ja kuidas need tingimused toetavad selle ettevõtte toimimist ja arengut. (Lundvall 1992, Polt et al. 2001, Kuhlmann ja Arnold 2001, Tether 2002).

Ülikooli olulisus teadmusallikana rõhutatakse ka erinevates Euroopa Komisjoni uuringutes ja raportites (European Commission 2006, 2009, Healy et al. 2012, Allinson et al. 2013, 2015) ning strateegia „Euroopa 2020“ suunab liikmesriike tugevdama ettevõtete-ülikoolide koostööd (European Commission 2010). Teaduskirjanduses on palju uuritud ülikoolide kasulikkust teadmusallikana, sealhulgas ka seda, kuidas ülikoolist saadav teadmus täiendab teistest allikatest saadud teadmust, näiteks Cassiman ja Veugelers (2006), Belderbos et

al. (2006), Love ja Roper (2009), Huang ja Yu (2011), Roper ja Arvanitis (2012), Temel et al. (2013), Fındık ja Beyhan (2015).

Samas näitavad erinevad ettevõtete-ülikoolide koostööl põhinevad uuringud, et ettevõtete-ülikoolide vahelise koostöö tase on madal. See kehtib nii uuringute kohta, mis vaatavad ettevõtete seisukohta antud küsimuses (Euroopa Innovatsiooniuuringud) kui ka neile, kes on küsinud ülikoolide arvamust (Davey et al. 2011, 2018, Kaymaz ja Eryiğit 2011, Chandrasekaran et al. 2015).

Ettevõtete-ülikoolide koostööd peetakse kasulikuks mõlemale osapoolele, samas tuleb tähele panna, et koostööga kaasnevad ka kulud (Hall et al. 2001, Hall et al. 2003, Laursen ja Salter 2006). Suuremas pildis on ettevõtete-ülikoolide koostöö kasulik tervele ühiskonnale ja selle arengule, kuid koostöö on siiski madalal tasemel. Seetõttu tekib hulk küsimusi koostöö madala taseme kohta. Miks tehakse vähe koostööd? Mis on peamised barjäärid koostöö tegemisel? Mis iseloomustab ettevõtteid, kes teevad ülikoolidega koostööd? Mis iseloomustab ülikoole, kes teevad ettevõtetega koostööd? Mida saaks teha ettevõtete-ülikoolide koostöö suurendamiseks? Kuidas parandada teadmuse liikumist teadmuse kolmnurga sees? Mis on riigi roll selles protsessis?

On palju teoreetilisi ja empiirilisi töid, mis uurivad erinevaid osapooli innovatsioonisüsteemi sees. Tuginedes innovatsiooniuuringute kirjandusele, võib leida mitmeid uurimislünki. Mõnele neist keskendutakse ka käesolevas doktoritöös. Euroopa riikide võrdlevanalüüs on üks neist uurimislünkadest (käsitletakse esimeses ja teises uuringus). Võrdlevanalüüs on oluline mõistmaks, millised tulemused on üldistatavad ja millised on riigispetsiifilised. See võimaldab paremini põhjendada saadud tulemusi ja panna need konteksti. Samal ajal annavad võrdlevuuringud hea sisendi poliitikameetmete kujundamiseks ja parimate praktikate leidmiseks.

Riikide võrdlemine võimaldab vastata järgmistele küsimustele: mida saaks teha ettevõtete-ülikoolide koostöö suurendamiseks? Kuidas parandada teadmuse liikumist teadmuse kolmnurga sees? Mis on riigi roll selles protsessis?

Uuring 1 keskendub ettevõtete-ülikoolide koostööd soodustavate tegurite välja selgitamisele ning nagu mainitud, aitab täita uurimislünka, mis on seotud võrdlevanalüüsi puudumisega. Ehkki ettevõtete-ülikoolide koostöötegureid on palju uuritud, põhinevad varasemad uuringud enamasti ühe riigi andmetel, näiteks Tether (2002), Laursen ja Salter (2004), Volpi (2014), kelle tööd põhinevad Ühendkuningriigi andmetel, Busom ja Fernández-Ribas (2008), Segarra-Blasco ja Arauzo-Carod (2008), Guimón ja Salazar (2014), kelle tööde fookus on Hispaania andmetel. Leidub ka töid, kus analüüsi on kaasatud rohkem kui üks riik, kuid ei toimu riikide võrdlust, vaid ühendatakse erinevate riikide andmed ning hinnatakse üks mudel ühendatud andmete pealt. Sellist lähenemist on näiteks kasutanud Mohnen ja Hoareau (2003), Fontana et al. (2006) ja Fernández López et al. (2014).

Teine uudne aspekt esimese uuringu puhul on kodu- ja välisülikoolide eristamine. Eraldi vaadeldakse koostöötegureid, mis soodustavad koostööd kodu- ja välisülikoolidega. See võimaldab näha, millised ettevõtted vajavad teadmust väljaspool riigi innovatsioonisüsteemi piire. See omakorda annab sisendit

ettevõtete-ülikoolide koostöömeetmete kujundamiseks. Kolmas uurimislünk, mida esimene uuring täidab, on seotud riigi taustatunnustega. Tänu võrdlevanalüüsile on võimalik analüüsi kaasata ka riike iseloomustavad tegurid, nagu sissetulekutase, uurimisasutuste kvaliteet, õigusliku raamistiku efektiivsus jne. See võimaldab analüüsida ettevõtete-ülikoolide koostöötegureid erineva arengutasemega innovatsioonisüsteemide lõikes. Varasemates uuringutes on see võimalus puudunud just seetõttu, et need on keskendunud vaid ühe riigi analüüsimisele. Nii koostöö kui selle tegurid on otseselt seotud innovatsioonisüsteemi arenguga. Innovatsioonisüsteem võib toimida nii koostööd soodustava kui takistava tegurina (Polt et al. 2001).

Uuring 2 annab detailse ülevaate ja head taustateadmised poliitikameetmetest, mis on suunatud ettevõtete-ülikoolide koostöö toetamiseks Euroopa riikides. Teise uuringu panus teaduskirjandusse seisneb detailse andmebaasi loomises. Andmebaas sisaldab ettevõtete-ülikoolide koostöö toetamisele suunatud poliitikameetmete kirjeldusi, näiteks seda, kes saab meedet taotleda, kes on kaasfinantseerijaks, kas koostöö ülikooliga on märgitud kui kohustuslik tegevus või mitte jne. Taolise andmebaasi loomine võimaldab kergesti võrrelda erinevates Euroopa riikides kasutusel olevaid poliitikameetmeid ja seda on võimalik kasutada ka tulevaste uuringute jaoks.

Juba Schumpeteri (1934) ja Kirzneri (1973) klassikalistes töödes rõhutatakse ettevõtja rolli olulisust innovatsiooniprotsessis ja majanduskasvus. Globaalse ettevõtlusmonitooringu (GEM 2018) andmetel on aga ettevõtlusaktiivsuse tase Euroopas endiselt madal. Ettevõtlusaktiivsuse tõstmiseks on järjest suuremat tähelepanu pööratud ettevõtlusõppele (Fiet 2001, Jones ja English 2004, Löbler 2006, Krueger, 2007, Higgins ja Elliott 2011). Ehkki ettevõtlusõpet on propageeritud ja rakendatud juba mõnda aega, ei ole see andnud soovitud tulemust ettevõtlusaktiivsuse tõstmisel. See on viinud diskussioonideni, kuidas õpetada ettevõtlust nii, et õppest oleks rohkem kasu (Gibb 2002, Jones ja English 2004) kõigile innovatsioonisüsteemi osalistele, sealhulgas innovaatilistele ettevõtetele.

Ettevõtlusharidust nähakse kui üht võimalikku majanduskasvu vedurit, sest see toetab ärivõimaluste nägemise oskust ja suurendab kavatsusi hakata ettevõtjaks (Rasmussen and Sørheim 2006, Matlay 2008, Raposo and do Paço 2011, Rauch and Hulsink 2015). Vähe on aga tähelepanu pööratud erinevatele ettevõtlushariduse õpetamismeetoditele ja sellele, kuidas erinevate õpetamismeetodite kasutamine seostub innovatsiooniga. Lisaks suurele hulgale varasemale teadustööle aitab erinevate ettevõtlusharidusega seotud õpetamismeetodite uurimine mõista, kuidas toetab ettevõtlus innovatsiooni ja arengut läbi ettevõtlushariduse. Seega võimaldab ettevõtlushariduse õpetamismeetodite uurimine paremini aru saada innovatsiooni ja ettevõtluse seostest. Vaatamata teema olulisusele, ei ole piisavalt võrreldud ettevõtlushariduse õpetamismeetodeid õpitulemuste kontekstis. Kirjanduses leidub nii teoreetilisi töid, mis selgitavad õpitulemuste erinevust ettevõtlushariduses kasutatavate erinevate õpetamismeetodite korral (Gibb 2002, Jones ja English 2004) kui empiirilisi töid, mis võrdlevad ettevõtlushariduse ja mitte-ettevõtlushariduse õpitulemusi, kuid ei vaatle ettevõtlushariduse-siseselt erinevaid õpetamismeetodeid (näiteks Charney ja

Libecap 2000, Noel 2002, Graevenitz et al. 2010, Fayolle ja Gailly 2015, Dickson et al. 2008). See uurimislünk on käesolevas doktoritöös kolmanda uuringu keskmes.

Kokkuvõttes võib öelda, et doktoritöö on seotud kolme erineva innovatsiooniuuringute-alase kirjanduse suunaga, mis panustavad ettevõtete-ülikoolide koostöö uurimisse innovatsioonisüsteemi kontekstis. Riigi innovatsioonisüsteem ise ei ole töö peamine fookus, vaid abistav raamistik ettevõtete-ülikoolide koostööga seotud komponentide (ettevõtted, ülikoolid, valitsus) uurimiseks.

Töö eesmärk ja ülesanded

Töö eesmärk on anda detailne ülevaade ettevõtete-ülikoolide koostöö põhielementidest riigi innovatsioonisüsteemi kontekstis, rõhuasetusega Euroopa riikide võrdlusel. Kõik kolm doktoritöö artiklit uurivad ettevõtete-ülikoolide koostööd, samas keskendub iga uuring erinevale ettevõtete-ülikoolide koostöö osapoolele. Esimene uuring käsitleb ettevõtte karakteristikuid, mis on seotud ülikoolidega koostöö tegemisega, teine uuring valitsusepoolseid meetmeid ettevõtete-ülikoolide koostöö toetamiseks ja kolmas uuring erinevaid õpetamismeetodeid, olles seeläbi seotud kolmanda koostöö osapoolega – ülikooliga. Ettevõtete-ülikoolide koostööd uuritakse töös kolmel erineval tasandil: riigi tasand (uuringus 2), ettevõtte-tasand (uuringus 1) ja indiviidi tasand (uuringus 3). Seega on doktoritöös ühendatud erinevad kirjandussuunad laiemast innovatsiooniuuringu kirjandusest, millest iga suund on seotud ettevõtete-ülikoolide koostööga.

Uurimiseesmärgi täitmiseks on püstitatud järgmised uurimisülesanded:

1. Anda teoreetiline ülevaade raamistikust, mis piiritleb ettevõtete-ülikoolide koostöö uurimist (alapeatükk 1.1)
2. Tuua välja teadmuse otsimise aspektid, mis loovad tausta ettevõtete-ülikoolide koostöö mõistmiseks (alapeatükk 1.2)
3. Anda süsteemne ülevaade ettevõtete-ülikoolide ettevõtte-poolsetest koostööteguritest (alapeatükk 1.3)
4. Anda ülevaade hariduse olulisusest innovatsioonisüsteemis (alapeatükk 1.4)
5. Leida ja võrrelda koostöötegureid Euroopa riikide lõikes (peatükk 2)
6. Koostada andmestik, et võrrelda meetmeid, mis on suunatud ettevõtete-ülikoolide koostöö toetamiseks Euroopa riikide lõikes (peatükk 2)
7. Võrrelda erinevate ülikoolis kasutatavate õpetamismeetodite abil saavutatud õpitulemusi ettevõtlushariduse näitel (peatükk 2)
8. Analüüsida empiirilisi tulemusi riigi innovatsioonisüsteemi kontekstis (peatükk 3)

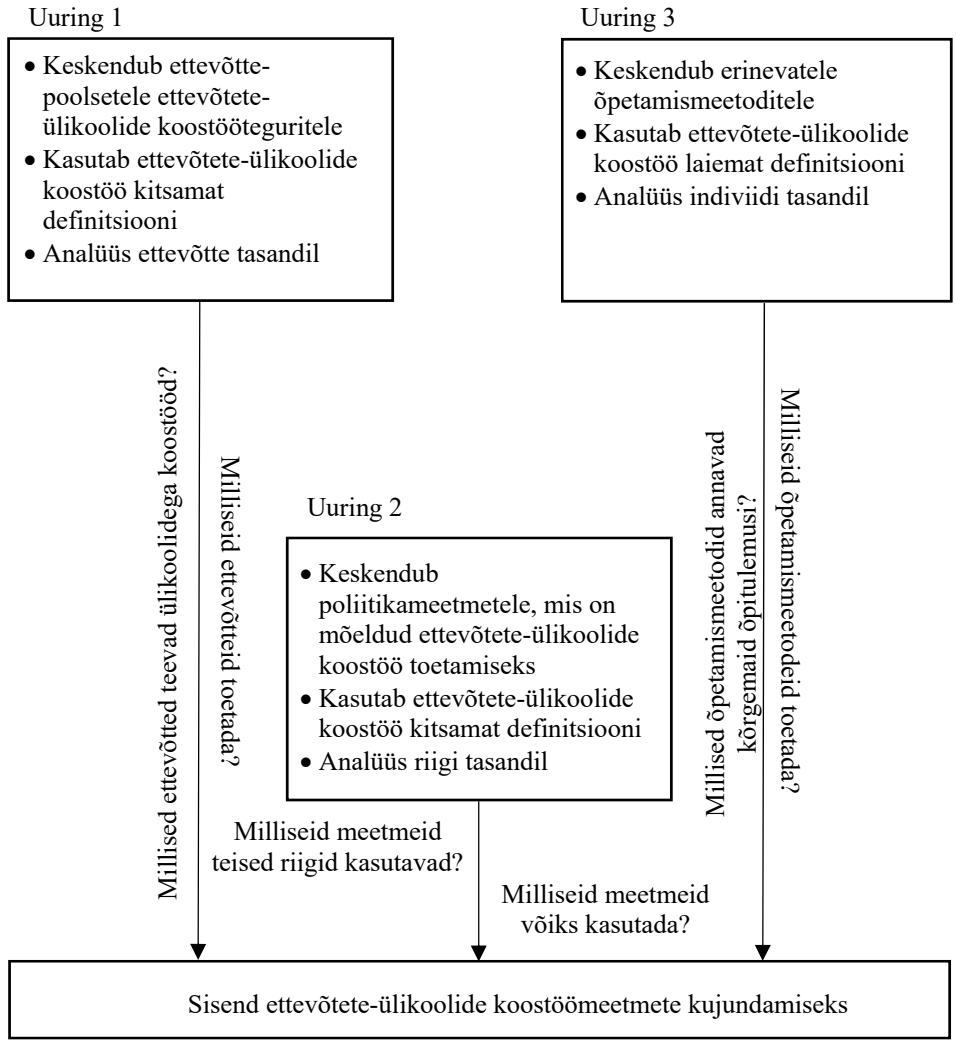
Töö ülesehitus ja teoreetiline taust

Töö koosneb kolmest peatükist. Esimene peatükk annab teoreetilise ülevaate ettevõtete-ülikoolide koostöö uurimise raamistikust. Teine peatükk koosneb empiirilistest uuringutest. Esimene uuring analüüsib ettevõtete-ülikoolide koostöötegureid Euroopa riikide lõikes. Teine uuring sisaldab samuti Euroopa riikide võrdlevanalüüsi, võrreldakse erinevates riikides kasutatavaid meetmeid ettevõtete-ülikoolide koostöö toetamiseks. Kolmas uuring võrdleb kahe erineva õpetamismeetodiga saavutatud õpitulemusi ettevõtlushariduse vallas. Kolmandas peatükis arutletakse empiiriliste tulemuste üle, tehakse kokkuvõte tööst, juhitakse tähelepanu töö piirangutele ja antakse soovitusi tuleviku uuringuteks. Joonis 1 annab ülevaate töös kasutatud uuringute kohta.

Töö teoreetiline raamistik annab esmalt ülevaate ülikooli muutunud rollist, millega on kaasas käinud muutused ka teiste ettevõtete-ülikoolide koostööga seotud osapoolte rollides. See on olnud eelduseks ettevõtete-ülikoolide koostöö kasvule. Lisaks muutunud rollidele, käsitletakse töö teoreetilises osas erinevaid mudeleid, mis pakuvad raamistikku ettevõtete-ülikoolide koostöö uurimiseks, näiteks kolmikheeliksi mudel (*triple helix model*), teadmuse kolmnurga (*knowledge triangle*) kontseptsioon, muutused teadmuse loomise viisides ja muutused innovatsioonimudelites.

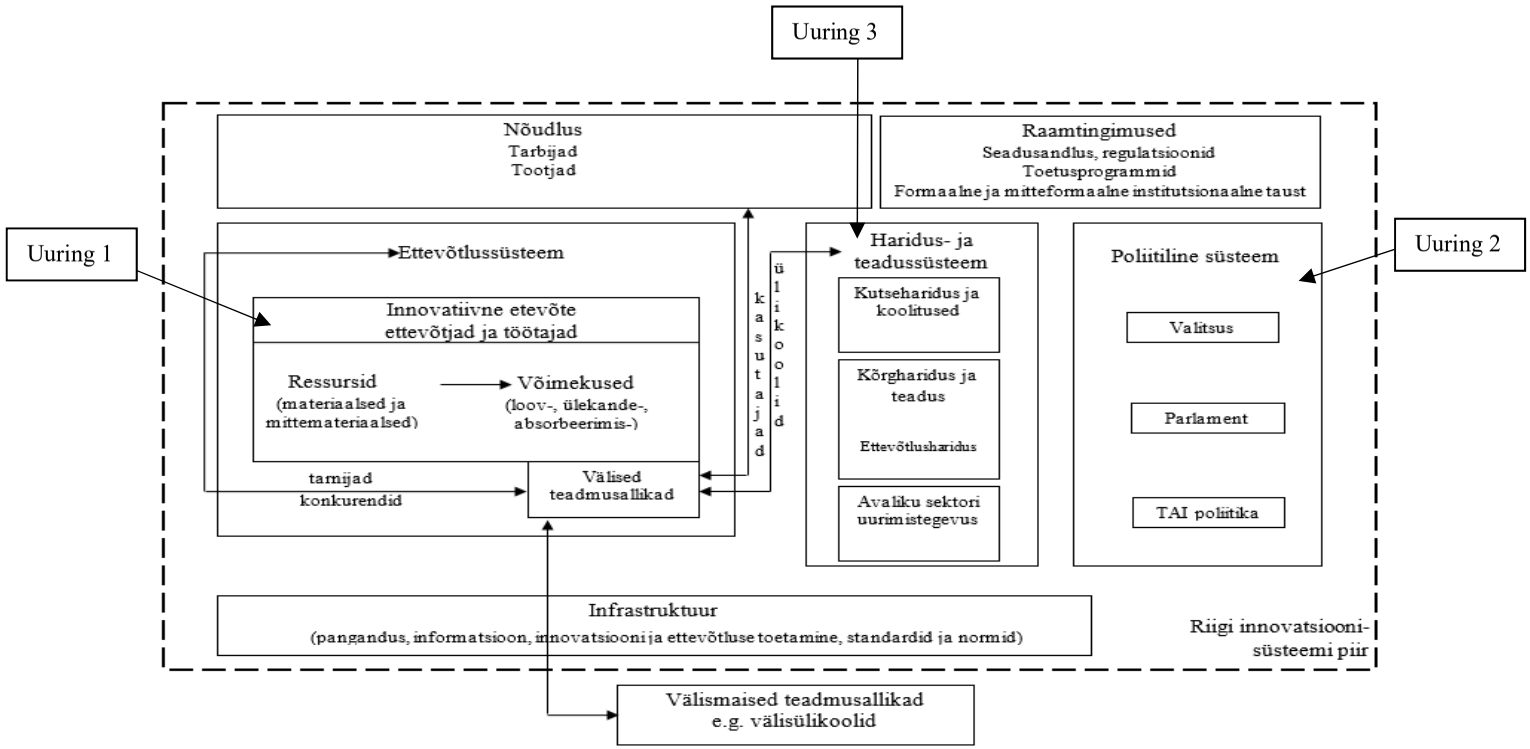
Läbi aja on ülikoolid saanud juurde uusi rolle, alustades õpetamisest (Wissema 2009), millele lisandus esimese akadeemilise revolutsiooniga teadustöö (Etzkowitz and Webster 1998) ja teise akadeemilise revolutsiooniga ühiskonda panustamine Etzkowitz and Viale 2010). Hiljuti on kirjanduses arutatud ka kolmanda akadeemilise revolutsiooni ja ülikoolide rolli üle kohaliku majanduse vedurina (Zuti and Lukovics 2015). Kolmas akadeemiline revolutsioon on seotud ettevõtliku ülikooli tekkega (Clark 2001). Ettevõtlikult ülikoolilt oodatakse mitmete ülesannete täitmist. Esiteks, pakkuda tudengitele vajalikke teadmisi ja oskusi, et hakata ettevõtjaks ning teiseks, käituda ise ettevõtlikuna (Schulte 2004). Ettevõtliku ülikooli tekkimine sõltub seda ümbritsevast keskkonnast, eriti ettevõtluse ökosüsteemist (Stam and Spigel 2016).

Ülikooli rolli muutudes muutuvad ka seosed ülikooli ja ettevõtete vahel (Etzkowitz ja Leydesdorff 1998). Globaliseerumine, mis on ka üks ülikoolide rolli muutumise põhjustaja, sunnib ka ettevõtjaid otsima uusi teadmusallikaid, et püsida konkurentsis (Rothwell et al. 1974, Radosevic ja Yoruk 2012). Tuntuim mudel, mis kirjeldab ettevõtete-ülikoolide koostööd, on kolmikheeliksi mudel (Etzkowitz 1993, Etzkowitz ja Leydesdorff 1995), kus ülikooli, ettevõtte ja valitsuse piirid kattuvad ning eelnimetatud institutsioonid võtavad üle üksteise rolle (Etzkowitz ja Leydesdorff 2000, Etzkowitz 2003). Näiteks täidavad ülikoolid ettevõtlikke ülesandeid, nagu ettevõtete loomine, samal ajal arendavad ettevõtted akadeemilisi dimensioone, jagades omavahel teadmust ja koolitades töötajaid (Leydesdorff ja Etzkowitz 1998). Ka valitsuse jaoks tekivad uued funktsioonid, nagu avalik ettevõtja ja riskikapitalist (Etzkowitz 2003). Tänu kattuvatele rollidele leiab ettevõtete, ülikoolide ja valitsuse vahel aset aktiivne koostöö.



Joonis 1. Ülevaade töös kasutatud uuringute kohta (autori koostatud).

Ülikooli roll ja seega ka ülikooli koostoimimine ümbritseva keskkonnaga on ajas muutunud. Samaaegselt on muutunud keerulisemaks ja süstemaatilisemaks mudelid, mis kirjeldavad ülikooli koostööd teiste innovatsioonisüsteemi osapooltega (Etzkowitz ja Leydesdorff 2000, Etzkowitz 2003, Carayannis ja Campbell 2009, Carayannis ja Campbell 2011, Carayannis et al. 2012). Riigi innovatsioonisüsteemi käsitlust (Freeman 1987, Lundvall 1992, Nelson 1993) nähakse kui abistavat konteksti ettevõtete-ülikoolide vahelise koostöö uurimiseks. Joonis 2 illustreerib riigi innovatsioonisüsteemi ja näitab, kuidas kolm doktoritöö uuringut on seotud innovatsioonisüsteemi kontekstiga.



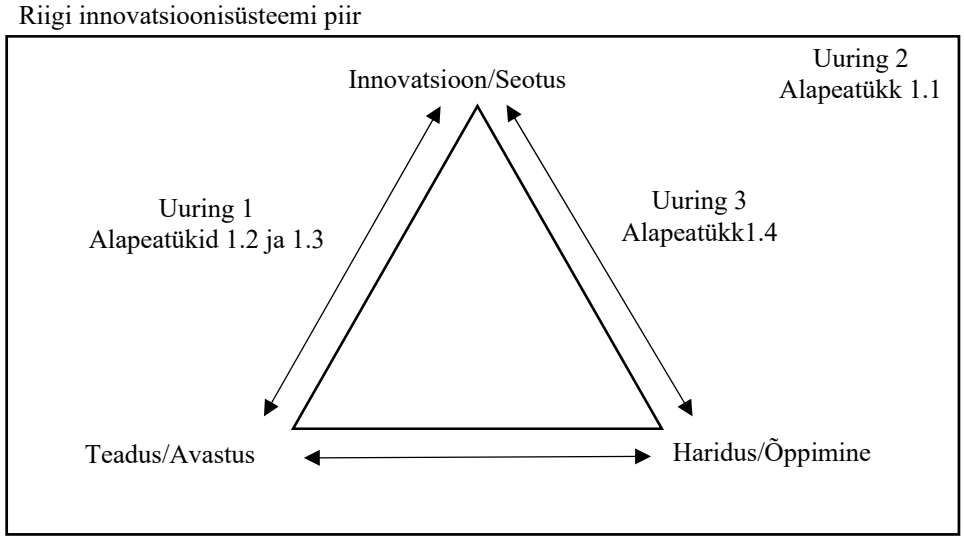
Joonis 2. Ettevõtte teadmuse allikad riigi innovatsioonisüsteemis (Kuhlmann ja Arnold 2001, Tether and Tajar 2008 autori täiendused).

Valitsuse roll ühe osapoolena ettevõtete-ülikoolide koostööst on samuti ajas muutunud. Kui algselt nähti valitsusel juhtivat rolli, siis nüüdseks on valitsusest kujunenud võrdne partner ülikoolidele ja ettevõtetele (Etzkowitz 2003). Põhjus, miks valitsus osaleb ettevõtete-ülikoolide koostöös, on süsteemitõrked. Klein Woolthuis et al. (2005) toovad välja nimekirja süsteemitõrgetest, mis on kokku pandud varasema kirjanduse alusel. Kasutatud on näiteks järgmisi töid: Carlsson ja Jacobsson (1997), Edquist et al. (1998), Smith (1999). Koostatud nimekiri sisaldab kaheksat süsteemitõrget: infrastruktuuri-, siirde(ülemineku)-, rajasõltuvuse-, tugev ja pehme institutsionaalne tõrge, tugev ja nõrk võrgustiku tõrge ja suutlikkuse tõrge. Süsteemitõrked pakuvad põhjendusi valitsusepoolseks sekkumiseks ja seetõttu aitavad selgitada erinevate poliitikameetmete kujundamist, mida käsitletakse uuringus 2.

Üks uuemaid kontseptsioone, mis seob erinevad innovatsioonisüsteemi osapooled (sarnaselt kolmikheeliksi mudelile), kuid keskendub rohkem tegevuse kui tegijate poolele, on teadmuse kolmnurk (Unger ja Polt 2017). Teadmuse kolmnurk kattub suures osas vanemate kontseptsioonidega, mis ettevõtete-ülikoolide koostööd selgitavad, kattuvusi leiab nii kolmikheeliksi mudeli kui ülikoolide kolmanda missiooniga (Unger ja Polt 2017). Teadmuse kolmnurga olulisus käesoleva doktoritöö jaoks on hariduse, teaduse ja innovatsiooni ühendamine. Kõik need kolm on doktoritöö keskmes ja seega pakub teadmuse kolmnurk keskset raamistikku ettevõtete-ülikoolide koostöö uurimiseks.

Haridus, teadus ja innovatsioon asuvad teadmuse kolmnurga nurkades (vt. joonis 3) ja teadmus liigub erinevate nurkade vahel, moodustades teadmuse ringluse (Sjoer et al. 2016). Euroopa Komisjoni (2005) kohaselt mängivad ülikoolid olulist rolli kõigis kolmes nurgas, kusjuures kolm nurka tähistavad ühtlasi ka kolme ülikooli missiooni (Lassnigg et al. 2016). Teadmuse kolmnurga kontseptsiooni eesmärgiks on nende kolme nurga parem omavaheline integreerimine (Cervantes 2017). Samal ajal märgivad kolm nurka ka majanduse konkurentsivõime vedureid (Sjoer et al. 2016). Vajadus teadmuse kolmnurga järele tuleneb vajadusest muuta ülikoolide rolli selliselt, et ülikooli väljundeid (haridust ja teadust) saaks paremini kasutada innovatsioonitegevusteks (Sjoer et al. 2016).

Käesoleva doktoritöö kontekstis on innovatsiooni ja teaduse vaheline külg seotud uuringuga 1 ning alapeatükkidega 1.2 ja 1.3. Esimene uuring analüüsib ettevõtete-ülikoolide koostöö jaoks olulisi tegureid ning võrdleb Euroopa riike nende arengutaseme alusel. Esimeses uuringus otsitakse vastust järgmisele uurimisküsimusele: millised tunnused iseloomustavad erinevates Euroopa riikides tegutsevaid ettevõtteid, kes teevad koostööd ülikoolidega? Alapeatükk 1.2 kajastab ettevõttepoolset teadmuse otsimist, sealhulgas käsitletakse otsimise laiust ja sügavust. Alapeatükk 1.3 annab süsteemse ülevaate ettevõtete-ülikoolide koostööteguritest varasema teaduskirjanduse põhjal.



Joonis 3. Teadmuse kolmnurk (Markkula 2011, Sjoer et al. 2016, autoripoolsete täiendustega).

Hariduse ja innovatsiooni vahele jääv kolmnurga külg on seotud kolmanda uuringu ning alapeatükiga 1.4, kus antakse ülevaade hariduse olulisusest innovatsioonisüsteemis. Uuring 3 käsitleb erinevaid ettevõtluse õpetamismeetodeid, mis on mõeldud vajaliku teadmuse- ja kompetentsibaasi loomiseks ettevõtluse vallas. Kolmanda uuringu abil saab vastuse kolmas doktoritöös püstitatud uurimisküsimus: Kas ülikoolis rakendatav õpetamismeetod on seotud õpiväljundite tasemega (inimkapitaliga), mis luuakse õpingute perioodi jooksul?

Teine uuring annab ülevaate erinevatest poliitikameetmetest, mis on mõeldud ettevõtete-ülikooli koostöö toetamiseks, sealhulgas selleks, et parandada teadmuse liikumist teadmuse kolmnurga eri nurkade vahel. Põhjendusi valitsuse sekkumiseks arutatakse alapeatükis 1.1. Lisaks loob alapeatükk 1.1 teoreetilise raamistiku ettevõtete-ülikoolide koostöö uurimiseks. Seega on nii uuring 2 kui alapeatükk 1.1 seotud teadmuse kolmnurga kui tervikuga, mitte konkreetse kolmnurga küljega. Teine uurimisküsimus, millele aitab vastata teine uuring, on: Kuidas toetatakse erinevates Euroopa riikides ettevõtete-ülikoolide koostööd riiklikul tasandil? Teaduse ja hariduse vahelist kolmnurga külge doktoritöös ei käsitleta.

Metoodika ja andmed

Doktoritöö kolm uuringut kasutavad erinevaid andmeallikaid ja meetodeid oma uurimisküsimustele vastamiseks. Uuring 1 ja 2 põhinevad teisestel andmetel ning uuring 1 kasutab esmaseid andmeid, mis on kogutud Inna Kozlinska poolt (kes on üks kolmanda uuringu autoritest). Tabelis 1 on toodud andmed ja meetodid, mida on erinevates uuringutes kasutatud.

Tabel 1. Uuringutes 1–3 kasutatud andmed ja meetodid

Uuring	Meetod	Andmed
Uuring 1	Regressioonanalüüs Klasteranalüüs	Euroopa Innovatsiooniuuringu andmed 14 Euroopa riigi kohta (kättesaadavad Eurostati kaudu). Kokku 45 566 vaatlust (ettevõtte-tasandi andmed), mis katavad ajaperioodi 2006–2008. Lisaks kasutati andmed Euroopa Innovatsiooni Tulemuskaardilt (2010), Globaalsest konkurentsivõime raportist (2008–2009) ja Eurostatist (2017)
Uuring 2	Klasteranalüüs Dispersioonanalüüs	Andmeallikana kasutati „Inventory of Research and Innovation Policy Measures“, mis on kättesaadav Erawatch'i ja INNO-Policy TrendChart'i kaudu. Andmed on 23 Euroopa riigi kohta. Lisaks kasutati andmeid Eurostatist, Innovatsiooni Tulemuskaardilt (2010) ning uuringust „The State of European University-Business Cooperation“ (Davey et al. 2011)
Uuring 3	Struktuursete võrrandite modelleerimine Kovariatsioonanalüüs Kontent(sisu-)analüüs Pool-struktureeritud intervjuud	Andmed hiljutiste lõpetajate ja viimase aasta bakalaureusetudengite kohta koguti veebipõhise küsimustiku kaudu ajavahemikus märts-mai 2013 (vastajaid 306). Andmed ettevõtlus-õppejõudude kohta koguti pool-struktureeritud intervjuude kaudu ajavahemikus aprill-oktoober 2012 (8 intervjueeritavat)

Allikas: autori koostatud uuringute 1–3 põhjal.

Esimese uuringu jaoks oli peamiseks andmeallikaks Euroopa Innovatsiooni-uuring (*Community Innovation Survey*), mis annab ettevõtte-tasandil infot innovatsioonitegevuste kohta, sealhulgas ettevõtete-ülikoolide koostöö kohta innovaatilise koostöö kontekstis. Vastamaks esimesele uurimisküsimusele ja testimaks erinevate võimalike koostöötegurite olulisust ettevõtete-ülikoolide koostöö puhul, kasutati regressioonanalüüsi, täpsemalt logit mudelit. Lisaks Euroopa

Innovatsiooniuuringule kasutati esimeses uuringus infot ka Euroopa Innovatsiooni Tulemuskaardilt, Globaalsest konkurentsivõime raportist ja Eurostatist. Lisainfot kasutati erinevate riikide kohta taustainfo saamiseks, et selle info põhjal klasteranalüüsi abil riigigrupid moodustada. Riigigruppide moodustamine sarnaste taustatingimuste alusel võimaldab ökonomeetrilise analüüsi tulemusi sisukamalt tõlgendada.

Sarnaselt esimesele uuringule tugineb ka teine uuring teisestele andmetele, põhiliseks andmeallikaks on Erawatch'i „*Inventory of Research and Innovation Policy Measures*". See andmebaas sisaldab detailset informatsiooni riikide poliitikameetmete kohta, sealhulgas erinevate meetmete rahastamine (eelarve, rahastaja), infot selle kohta, kes ja millistel tingimustel saavad neid meetmeid taotleda, samuti sisaldab meetmete algus- ja lõpptähtaegu. Eelnimetatud andmeid kasutatakse vastamaks teisele uurimisküsimusele: kuidas toetatakse ettevõtete-ülikoolide koostööd erinevates Euroopa riikides poliitikameetmete abil? Teise uuringu eesmärgi täitmiseks ja koostöömeetmetest mustrite leidmiseks kasutati ka teises uuringus klasteranalüüsi.

Kolmas uuring erineb esimesest kahest, see tugineb esmastele andmetele. Andmeid koguti alles hiljuti ülikooli lõpetanud ja viimasel õppeaastal (bakalaureuseõppes) olevate Läti ärikoolide tudengite kohta. Uuringu andmed koguti veebiküsitluse teel ajavahemikus märts-mai 2013 ning uuringusse oli kaasatud neli ärikooli. Kõik uuringu andmed on kogutud Inna Kozlinska poolt. Lisaks intervjueeriti samadest ärikoolidest kaheksat ettevõtlus-õppejõudu. Intervjuude tegemise eesmärk oli saada informatsiooni koolides kasutatava õpetamismeetodi kohta.

Tudengitelt kogutud vastuste abil koostati mõõtmismudel kolme õpiväljundi mõõtmiseks, milleks on kognitiivne, oskuspõhine ja afektiivne õpiväljund. Mõõtmismudeli hindamiseks kasutati kinnitavat faktoranalüüsi, puhastamisprotsessis eemaldati madala laadungiga küsimused ning kontrolliti nii mudeli ühilduvus- kui diskriminantvaliidsust ja reliaablust. Teise sammuna koostati struktuursete võrrandite mudel ning hinnati õpiväljundite ja kasutatud õpetamismeetodite vahelisi seoseid.

Kokkuvõte töö põhitulemustest

Kolm doktoritöö aluseks olevat uuringut keskenduvad igaüks erinevale ettevõtete-ülikoolide koostöö osapoolele ning uurivad ettevõtete-ülikoolide koostööd erinevate nurkade alt. Ettevõtte poole pealt uuritakse, millised ettevõtted teevad ülikoolidega suurema tõenäosusega koostööd ja seda 14 Euroopa riigi lõikes. Valitsuse vaatenurgast keskendutakse ettevõtete-ülikoolide koostöö toetamisele suunatud poliitikameetmete võrdlusele üle 23 Euroopa riigi ning ülikooli suunalt analüüsitakse inimkapitali loomise protsessi sõltuvana erinevatest õpetamismeetoditest.

Esimene uurimisküsimus, millele doktoritöös vastust otsitakse, oli: millised tunnused iseloomustavad erinevates Euroopa riikides tegutsevaid ettevõtteid,

kes teevad koostööd ülikoolidega? Neid ettevõtetele iseloomulikke tunnuseid uuritakse järgmistes Euroopa riikides: Bulgaaria, Eesti, Hispaania, Itaalia, Küpros, Leedu, Läti, Portugal, Rumeenia, Saksamaa, Slovakkia, Sloveenia, Tšehhi Vabariik ja Ungari. Lisaks riikidevahelisele võrdlusele võrreldakse koostöötegureid ka kodu- ja välisülikoolide lõikes. Analüüsi on kaasatud ka riikide taustatingimused ehk tegurid, mis iseloomustavad riigi innovatsioonisüsteemi arengut, nagu riigi sissetulekutase, uurimisasutuste kvaliteet ja õigusliku raamistiku efektiivsus.

Lihtsustamaks 14 riigi omavahelist võrdlust, viidi läbi klasteranalüüs, et grupeerida riigid vastavalt nende innovatsioonisüsteemi arengule. Klasteranalüüsi tulemusena moodustati neli riikide gruppi, kusjuures Saksamaa moodustas eraldiseisva grupi, mida iseloomustab hästi arenenud innovatsioonisüsteem. Teise grupi moodustasid Küpros, Eesti, Portugal, Hispaania ja Sloveenia. Tšehhi Vabariik, Ungari ja Itaalia kuulusid kolmandasse gruppi, mida iseloomustab madalam sissetulekutase võrreldes kahe esimese grupiga ja kus innovatsioonisüsteemi võib pidada keskpäraselt toimivaks. Neljandasse gruppi kuulusid Leedu, Läti, Slovakkia, Bulgaaria ja Rumeenia, mida iseloomustab pigem nõrk innovatsioonisüsteem ja keskmine sissetulekutase.

Esimene koostöötegurite rühm, mida analüüsiti, on seotud ettevõtte suurusega. Ainus riigigrupp, kus ettevõtte käive on positiivselt ja statistiliselt olulisel määral seotud ülikoolidega koostöö tegemisega, on grupp, kus keskmine ettevõtete käive on kõige madalam, võrreldes teiste riigigruppidega. Sellesse gruppi kuuluvad Tšehhi Vabariik, Ungari ja Itaalia. Teise tegurina vaadeldi kontserni kuulumist, tulemused näitasid, et ettevõtted, kes kuuluvad kontserni, teevad ülikoolidega väiksema tõenäosusega koostööd. Selle põhjuseks võib olla teiste, kontsernisiseste teadmusallikate kasutamine (Tether 2002).

Teine suurem koostöötegurite rühm hõlmab erinevaid innovatsioonitegevusi, mille kohta Innovatsiooniuuringus küsitakse. Doktoritöö tulemused näitavad, et seos ettevõtete-ülikoolide koostöö ja innovatsioonitegevuste vahel sõltub innovatsioonitegevuse iseloomust. Töös selgus, et tegevused, mis peegeldavad ettevõtte enda absorbeerimisvõimet (*absorptive capacity*), nagu ettevõtte-sisene teadus- ja arendustegevus, suurendavad tõenäosust teha koostööd ülikoolidega. Samas tegevused, mis näitavad teadmuse hankimist väljastpoolt ettevõtet, nagu seadmete ja masinate soetamine, pigem vähendavad tõenäosust valida koostööpartneriks ülikool. Need tulemused on mõningases vastuolus varasemate empiiriliste töödega, kus leiti kas positiivseid või statistiliselt mitteolulisi seoseid erinevate innovatsioonitegevuste ja ettevõtete-ülikoolide koostöö vahel.

Kolmanda koostöötegurite rühma moodustavad näitajad, mis iseloomustavad ettevõtte rahvusvahelistumise taset. Näitajatena kasutati töös tunnust, kas ettevõtte ekspordib või mitte ja teise näitajana välisosaluse olemasolu. Töös leiti, et ettevõtted, kes ekspordivad, teevad ülikoolidega suurema tõenäosusega koostööd, eriti välismaiste ülikoolidega. Eksportivad ettevõtted puutuvad kokku suurema konkurentsiga ja seetõttu on suurem ka vajadus väliste teadmusallikate järele, sealhulgas ülikoolidelt saadava teadmuse järele. Suurem koostöö tõenäosus välisülikoolidega on arusaadav, sest välistel turgudel tegutsemine vajab ka

teistsugust teadmust, mida koduülikoolid ei ole ehk võimelised pakkuma. Samas on eksportivatel ettevõtetel mõnevõrra lihtsam leida partnereid välisülikoolide seast (võrreldes ettevõtete, kes ei ekspordi), sest neil on väliste partneritega töötamise kogemus juba olemas.

Välisosaluse puhul oleneb ülikoolidega koostöö tegemise tõenäosus ülikooli asukohast. Välisülikoolidega koostöö tegemisel on välisosalus koostööd toetav tegur, koduülikoolide puhul aga takistav tegur.

Rahvusvahelistumise taseme puhul on selgelt näha erinevused riigigruppide vahel. Eeltoodud tulemused välisosaluse kohta kehtivad vaid riikidele, kellel on paremini arenenud innovatsioonisüsteem. Nõrgema innovatsioonisüsteemiga riikides (nagu Lätis, Bulgaarias ja Rumeenias) on välisosaluse olemasolu ebaoluline koostöötegur nii kodu- kui välisülikoolidega koostöö tegemisel.

Eksportivate ettevõtete puhul eristub teistest riigigruppidest keskpäraselt toimiva innovatsioonisüsteemiga grupp, kuhu kuuluvad Tšehhi Vabariik, Ungari ja Itaalia. Nendes riikides ei tee eksportivad ettevõtted suurema tõenäosusega koostööd koduülikoolidega, aga eksportimine on soodustav tegur välisülikoolidega koostöö tegemisel. Selle põhjuseks võib olla kohalike ülikoolide nõrgem teadusvõimekus, eriti Ida- ja Kesk-Euroopa riikides, nagu Tšehhi Vabariik ja Ungari. Seetõttu peavad ettevõtted otsima koostööpartnereid väljastpoolt riigipiiri, et omandada teadmust, mis on vajalik globaalsetel turgudel tegutsemiseks. Teisisõnu ei suuda kohalikud ülikoolid pakkuda eksportivatele ettevõtetele vajalikku teadmust, mistõttu teevad need ettevõtted suurema tõenäosusega koostööd välisülikoolidega. Teiste riigigruppide puhul tegid eksportivad ettevõtted suurema tõenäosusega koostööd nii kodu- kui välisülikoolidega.

Viimane koostöötegurite rühm, mida uuriti, on seotud välise rahastamisega. Töös eristati valitsuse ja Euroopa Liidu poolset rahastust. Nii ettevõtted, kes said rahalist toetust valitsuselt, kui need, keda toetas Euroopa Liidu rahastus, teevad suurema tõenäosusega koostööd nii kodu- kui välisülikoolidega. Ühest küljest on rahaline toetus vajalik, et leevendada omavahendite puudumist, mis takistab ettevõtete-ülikoolide koostööd (Busom and Fernándes-Ribas (2008). Teisest küljest nähakse koostööd ülikoolidega kui üht võimalust toetuse taotlemiseks. (Mohnen ja Hoareau 2003, Seppo et al. 2014, Guimón ja Salazar 2014)

Esimese uuringu empiirilised tulemused näitavad, et ettevõtete-ülikoolide koostöötegurid on seotud nii ülikooli asukoha kui riigi innovatsioonisüsteemi arengutasemega.

Teine töös püstitatud uurimisküsimus oli: kuidas toetatakse erinevates Euroopa riikides ettevõtete-ülikoolide koostööd riiklikul tasandil? Teisisõnu uuritakse, kuidas peegelduvad riigi-spetsiifilised innovatsioonisüsteemi aspektid ettevõtete-ülikoolide koostöö toetamises. Riigi innovatsioonisüsteemis ilmneb mitmeid tõrkeid, mõned neist on tihedamalt seotud ettevõtete-ülikoolide koostööga, nagu infrastruktuuritõrge, tõrked, mis on seotud erinevate võimekustega ning võrgustikutõrge (Metcalfe ja Georghiou 1998, Smith 2000, Gustafsson ja Autio 2011, García Manjón ja Romero Merino 2012, Hewitt-Dundas et al. 2017). Neid tõrkeid võib vaadelda kui ettevõtete-ülikoolide koostööd takista-

vaid tegureid ja läbi koostööd toetavate meetmete pakkumise püüab valitsus neid tõrkeid leevendada.

Teine uuring annab detailse ülevaate erinevatest koostöö toetamisele suunatud meetmetest 23 Euroopa riigis. Kuna analüüsi on kaasatud 23 riiki, on nende võrdlemine keeruline. Seega kasutati tulemuste kergemaks tõlgendamiseks klasteranalüüsi, mille tulemusel moodustus neli riigigruppi. Klasteranalüüsi aluseks olid näitajad, mis iseloomustavad ettevõtete-ülikoolide koostöö taset.

Holland kui teistest riikidest koostöömeetmete poolest selgelt eristuv riik, moodustas omaette grupi. Kõik Hollandi koostöömeetmetes on sätestatud koostöö kohustuslikkus ülikooliga, ükski nendest meetmetest ei ole kaasfinantseeritud Euroopa Liidu poolt ning Hollandis ei ole ühtki ettevõtete-ülikoolide koostöömeedet, mida saaks taotleda ettevõte üksinda. Teise grupi moodustasid Põhjamaad, Soome, Rootsi, Taani ja Norra. Saksamaa, Austria ja Belgia kuulusid kolmandasse gruppi ning neljas grupp oli kõige suurem, koosnedes 14 Euroopa riigist (Prantsusmaa, Iirimaa, Hispaania, Tšehhi Vabariik, Ungari, Itaalia, Eesti, Rumeenia, Portugal, Slovakkia, Läti, Bulgaaria, Leedu ja Poola).

Teine uuring näitab erinevusi Euroopa riikide poliitikameetmetes ja seeläbi ka erinevusi süsteemitõrgete adresseerimisel. Kõik ettevõtete-ülikoolide koostöömeetmed leevendavad võimekuste tõrget finantsilise võimekuse mõttes. Suures osas uutes Euroopa Liidu liikmesriikides on Euroopa Liit paljude meetmete puhul kaasfinantseerija rollis. See peegeldab nende riikide finantsvõimekuse tõrget. Näiteks Eestis kaasrahastas Euroopa Liit kõiki ettevõtete-ülikoolide koostöö toetamisele suunatud meetmeid. Teistes uutes liikmesriikides on olukord sarnane: vähe on meetmeid, mida kaasrahastaks erasektor. See näitab, et finantsvõimekuse tõrge on suuremaks probleemiks just uutes liikmesriikides. Kõige rohkem on erasektori rahastus kaasatud Taanis, Hollandis, Rootsis, neile järgnevad Norra, Saksamaa ja Soome.

Põhjamaadest koosnevas grupis on kõige rohkem meetmeid, kus ülikooliga koostöö on seatud kohustuslikuks. Esialgne kohustuslik koostöö aitab leevendada võrgustikutõrget ja võib viia pikaajalise koostööni. Ühest küljest aitab kohustuslik koostöö leevendada nõrka võrgustikutõrget ning ülikoolidega kokku viia neid ettevõtteid, kelle pole varasemat kogemust ülikoolidega koostöö tegemisel. Teisest küljest aitab see tõsta teadlikkust ülikoolist kui võimalikust koostööpartnerist (kui ettevõte kasutab teisi koostööpartnereid), see leevendab tugevat võrgustikutõrget.

Võttes kokku teise uuringu tulemused, võib öelda, et erineva taustsüsteemiga (innovatsioonisüsteemiga) riikides adresseeritakse süsteemitõrkeid erinevalt. Kõrgema ettevõtete-ülikoolide koostöö tasemega riikides on ettevõtete-ülikoolide koostöö toetamisele suunatud poliitikameetmed disainitud erinevalt, võrreldes uute Euroopa Liidu liikmesriikidega.

Kõik kolmandas uuringus püstitatud uurimisküsimused seostuvad õpiväljunditega. Töös uuritakse kolme õpiväljundit: suhtumine ettevõtlusesse, teadmised ettevõtluse kohta ja ettevõtlusega seotud oskused. Kolmandas uuringus võrreldakse, kas ettevõtlushariduses kasutatav õpetamismeetod peegeldub õpiväljundite erinevas tasemes (kas ühe õpetamismeetodiga saavutatakse kõrgemad õpi-

väljundid kui teise meetodiga). Kolmanda uuringu tulemused näitavad, et kogemuspõhine ettevõtlusharidus ei ole alati seotud kõrgemate õpiväljunditega, võrreldes traditsiooniliste õpetamismeetoditega. Tuginedes teoreetilistele töödele õpetamismeetodite erinevuse kohta, oodati, et kogemuspõhine õpetamine annab õpiväljundite osas kõrgemaid tulemusi. Saadud tulemuste üldistamisel tuleks aga olla ettevaatlik, sest tulemused põhinevad ühe riigi andmetel. Samas tõstatab kolmas uuring huvitava ja olulise küsimuse õpiväljundite erinevuse kohta, mida tasub tulevikus uurida suurema hulga riikide andmete põhjal.

Võttes kokku kolm doktoritöö empiirilist uuringut, võib öelda, et kõik kolm näitavad taustatingimuste (konteksti) olulisust. Esimeses uuringus leiti, et ettevõtete-ülikoolide koostöötegurid on erinevate innovatsioonisüsteemide lõikes erinevad.

Riikide lõikes saadud erinevad tulemused näitavad innovatsioonisüsteemi konteksti olulisust. Innovatsioonisüsteemide areng erineb selle poolest, kuidas on erinevad innovatsioonisüsteemi osapooled üksteisega seotud, kuivõrd arenenud need osapoolsed on, kuidas toimub teadmuse liikumine erinevate tegevuste (haridus, teadus, innovatsioon) vahel ning millises etapis on ülikoolid ettevõtlikuks ülikooliks kujunemise mõttes. Paljud ülikoolid on endiselt hädas väljakutsetega, mis kaasnevad ettevõtlikuks ülikooliks kujunemisega. See omakorda mõjutab ka ettevõtete-ülikoolide koostöö taset ning seda, millised ettevõtted ülikoolidega koostööd teevad.

Teises uuringus tulenevad erinevused poliitikameetmetes (Euroopa riikide vahel) jällegi riikide taustatunnustest. Iga uuringus 2 analüüsitud riigi puhul mängib toetusmeetmete kujunemisel rolli selle riigi innovatsioonisüsteem ja selle arengutase. Riikide innovatsioonisüsteemide erinevast toimimisest annab ülevaate näiteks Euroopa Innovatsiooni Tulemuskaart (*European Innovation Scoreboard*). Ettevõtete-ülikoolide koostöö toetamiseks mõeldud meetmed on Euroopa riikide lõikes heterogeensed seetõttu, et riigiti võivad peamised süsteemitõrked erineda ning samuti võivad erinevad olla nende tõrgete ulatus ja tähtsus.

Sarnaselt kahele esimesele uuringule näitab ka uuring 3 konteksti olulisust. Ehkki uuring 3 ei sisalda riikide omavahelist võrdlust, sõltub tulemuste tõlgendamine siiski Läti kui riigi kontekstist ehk riigi innovatsioonisüsteemi arengutasemest. Peamine kolmanda uuringu tulemus oli, et kogemuspõhine ja traditsiooniline ettevõtlusharidus ei anna kolme õpiväljundi osas erinevaid tulemusi. Miks ei leitud statistiliselt olulisi erinevusi uuringus 3, seda on võimalik põhjendada mitmeti. Laiemas kontekstis ei pruugi Läti nõrk ettevõtluse ökosüsteem ja infrastruktuur pakkuda toetavat keskkonda erinevate õpiväljundite tekkimiseks. Samuti võib põhjuseks olla tudengite ebapiisav valmidus ja ettevalmistus kogemuspõhiseks õppeks, sest peamise õpetamismeetodina on siiski levinud traditsiooniline õpe. Tulemusi võib mõjutada ka õppejõudude pedagoogiline ettevalmistus, eriti just olukorras, kus praktikud oma teadmisi edasi annavad.

Töö piirangud ja soovitused tulevasteks uuringuteks

Töö teoreetiline raamistik toetub riigi innovatsioonisüsteemi ja teadmuse kolmnurga kontseptsioonidele. Riigi innovatsioonisüsteemi kontseptsioon on innovatsiooniuuringute kirjanduses laialt kasutatud lähenemine, millel on omad piirangud. Innovatsioonisüsteemi kontseptsiooni on kritiseeritud selle liiga üldise lähenemise tõttu, kontseptsioon ei määratle oma piire (Edquist 1997). Samuti leiab kirjandusest diskussioone kontseptsiooni ala- (Fischer 2001) ja ületeoretiseerituse kohta (Edquist 2006). Leitakse, et riigi innovatsioonisüsteemi kontseptsiooni on keeruline poliitikakujundamisel kasutada (OECD 2002, Chaminade ja Edquist 2005).
Teadmuse kolmnurka nähakse kui poliitikast tulenevat kontseptsiooni, mida ei ole veel piisavalt analüüsitud ja hinnatud teadlaste poolt (Lassnigg et al. 2016).

Töö piirangud tulenevad ka töös kasutatud andmetest. Esimeses uuringus põhinevad regressioonanalüüsi tulemused Euroopa Innovatsiooniuuringu andmetel, Innovatsiooniuuringu andmetel on aga oma puudujäägid (Mairesse ja Mohnen 2010, Bogliacino et al. 2012, Galindo-Rueda ja Van Cruysen 2016). Innovatsiooniuuringus vastavad koostööpartnerite kohta vaid need ettevõtted, kes on märkinud, et nad tegelevad tehnoloogilise innovatsiooniga (toote- ja/või protsessiinnovatsiooniga). Seega ei vasta teiste innovatsioonitegevustega või innovaatilise tegevusega üldse mitte tegelevad ettevõtted oma koostööpartnerite kohta. See tähendab, et esimese uuringu valim koosneb ainult tehnoloogilise innovatsiooniga tegelevatest ettevõtetest ning uuringu tulemused on seetõttu üldistatavad vaid tehnoloogilise innovatsiooniga tegelevatele ettevõtetele. Kõigis 14 Euroopa riigis, mis analüüsi kaasati, kasutatakse valimi moodustamisel samasugust loogikat, mis muudab riikidevahelise võrdluse võimalikuks (Euroopa Komisjon 2012).

Teine Innovatsiooniuuringu seostuv probleemkoht on küsimustiku *self-reporting* loomus (Galindo-Rueda ja Van Cruysen 2016), mis tähendab, et andmed võivad olla nihkega ja sõltuda sellest, kes parasjagu küsimustikule vastab.

Tasub märkida, et andmete kättesaadavuse tõttu koosneb esimese uuringu valim peamiselt Kesk- ja Ida-Euroopa riikidest, mis on kaasatud uuringusse just detailsete andmete olemasolu tõttu.

Euroopa Innovatsiooniuuringus kasutatud metodoloogia on riigiti sama ja seetõttu võimaldab riikide omavahelist võrdlust. Siiski võib erinevusi esineda teatud muutujate või nende detailsusastme puhul, näiteks majandussektor, kus ettevõte tegutseb. Kõikide riikide kohta on olemas info majandussektori kohta, kuid sektorite agregeeritusetase on riigiti erinev (vastavalt Eurostati poolt kättesaadavaks tehtud andmetele). Seetõttu piirduti töös teenuste- ja tööstussektori eristamisega ning ei olnud võimalik kasutada sektorite jaotamist nende tehnoloogilise taseme alusel.

Järgmine piirang seostub esimese uuringuga, kuid mitte Innovatsiooniuuringu andmetega, nimelt on see seotud uuringus kasutatud ajaraamistikuga. Esimese uuringu kirjutamise ajal olid kõige uuemad kättesaadavad andmed ajavahemiku 2006–2008 kohta. See periood on eriline mitmes mõttes, uued

Euroopa Liidu liikmesriigid hakkasid sel ajaperioodil kasutama Euroopa Liidu fonde ja kaks uuringusse kaasatud riiki, Bulgaaria ja Rumeenia, astusid Euroopa Liitu 2007. aastal. Kolmandaks on tegemist perioodiga, mis eelnes majanduskriisile.

Vaatamata Innovatsiooniuuringu piirangutele, on siiski tegemist olulise innovatsioonitegevusi kajastava uuringuga. Innovatsiooniuuring annab nii kvantitatiivset kui kvalitatiivset infot innovatsioonitegevuste kohta ettevõtte tasandil ning seda erinevate innovatsiooniliikide lõikes (Mairesse ja Mohnen 2010). Lisaks on Innovatsiooniuuringu tulemused riigiti võrreldavad tänu ühtsele metodoloogiale. Veel üheks eeliseks Innovatsiooniuuringute puhu võib pidada nende regulaarsust ja seda, et uuringus osalemine on riikidele kohustuslik. (Eurostat 2017) Tänu uuringu regulaarsusele ja seal sisalduvale infole, on see heaks sisendiks poliitikakujundajatele, pakkudes võimalust jälgida ja võrrelda innovatsiooniga seotud tegevusi nii ajas kui riikide lõikes (Mairesse ja Mohnen 2010).

Tuleviku uuringute mõttes oleks huvitav võrreldes koostöötegureid üle majandustsükli. See annaks võimaluse analüüsida, mil määral on majanduslik keskkond seotud ettevõtete-ülikoolide koostööteguritega. Lisaks on võimalik laiendada analüüsi kaasatavate arenguindikaatorite hulka, mis võimaldaks leida põhjendusi riikidevaheliste erinevuste kirjeldamiseks. Ka sektoraalne innovatsioonisüsteem on üks võimalik uurimissuund, sest Innovatsiooniuuring võimaldab läbi viia sektori-tasandi analüüsi.

Tähelepanu tuleb pöörata ka sellele, et esimeses uuringus hinnatakse korrelatiivseid ja mitte kausaalseid seoseid koostöötegurite ja koostöö tegemise vahel. Mudelites esineb endogeensuse probleem, mis tähendab, et seos sõltuva ja selgitavate muutujate vahel ei ole nii ühene, näiteks ettevõtted, kes viivad läbi teadus- ja arendustegevusi teevad suurema tõenäosusega koostööd ülikoolidega. Samas võib seos olla ka teistpidise suunaga, ettevõtted, kes teevad koostööd ülikoolidega, viivad suurema tõenäosusega läbi ka erinevaid teadus- ja arendustegevusi. Innovatsiooniuuringu ühe laine kasutamisel on tegemist ristandmetega ja seetõttu ei ole võimalik kindlaks teha, millises järjekorras tegevused toimusid, kas enne tegeleti teadus- ja arendustegevusega või eelnes sellele koostöö ülikoolidega.

Kuna teine uuring kasutab samuti Euroopa Innovatsiooniuuringu andmeid, siis enamik eelmainitud Innovatsiooniuuringu piirangutest kehtivad ka teise uuringu puhul, sealhulgas *self-reporting*. *Self-reporting* on piiranguks ka uuringus „The State of European University-Business Cooperation“ (Davey et al. 2011), mida kasutatakse teises uuringus andmeallikana. Kui Innovatsiooniuuringus on vastajateks ettevõtete esindajad, siis Davey et al. (2011) uuringus ülikoolide esindajad.

Peamine andmebaas, mida teises uuringus kasutatakse, on „Inventory of Research and Innovation Policy“, mis sisaldab teadus- ja innovatsioonipoliitika meetmeid, samas võivad ka teiste valdkondade meetmed toetada ettevõtete-ülikoolide koostööd. Teise uuringusse kaasati vaid need meetmed, mille üheks eesmärgiks oli ettevõtete-ülikoolide koostöö toetamine. Teisi meetmeid, mis

võivad toetada ettevõtete-ülikoolide koostööd, kuid ei toonud seda oma eesmärgina välja, analüüsi ei kaasatud. On olemas ka teisi valitsusepoolseid tegevusi (lisaks toetusmeetmetele), mis võivad toetada ettevõtete-ülikoolide koostööd, neid tegevusi töös ei analüüsitud.

Tuleviku uuringutesse oleks võimalik kaasata poliitilisi ja institutsionaalseid tegureid erinevate riikide kohta, nagu on tehtud esimeses uuringus. Lisaks meetmete arvu analüüsimisele oleks hea kaasata ka meetmete eelarvete-alast informatsiooni, sest mõnes riigis võib olla palju väikese eelarvega meetmeid, mõnes teises riigis aga vähe ja suure eelarvega meetmeid. Seetõttu ei ole meetmete arv riigiti täielikult võrreldav. Teisest uuringust jäeti eelarvetega seotud info välja, sest esines palju puuduvaid väärtusi ning suuremate meetmete puhul ei olnud informatsiooni, kui suur osa eelarvest erinevatele alammeetmetele kulub.

Teises uuringus kasutatud andmebaas sisaldas informatsiooni ka meetmete mõjude kohta, kuid teise uuringu kirjutamise ajal polnud paljude meetmed veel lõppenud ning mõned meetmed lõppenud liiga hiljuti, et nende mõjule hinnang anda. Praeguseks hetkeks on aga paljud meetmed lõppenud ja nende mõju ka erinevates riigi raportites hinnatud.

Kolmas uuring põhineb indiviidi tasandi andmetel, need andmed on kogutud nelja Läti ärikooli lõpetanute või viimasel aastal olevate tudengite käest. Seega võivad töös toodud järeldused sõltuda Läti haridussüsteemi kontekstuaalsest raamistikust. Samuti kerkib ka kolmandas uuringus *self-reporting*'u piirang, sest vastajad peavad ise anda hinnangu koolist saadud teadmusele.

Hea võimalus uuringu edasi arendamiseks on longituuduuringu läbiviimine, mis võimaldaks paremini hinnata bakalaureuseprogrammi tulemusi, võrreldes praegu kasutusel olnud ristandmetega, kus nii eelnevat teadmust (enne õppima tulekut) kui koolist saadud teadmust pidid vastajad hindama samal ajahetkel. See võib põhjustada raskusi eelneva ja juurde saadud teadmuse eristamisel, seda enam, et lõpetamisest on osadel vastajatel juba teatud aeg möödas. Huvitav oleks näha, kas kolmandas uuringus tehtud järeldused jäävad püsima ka teistes riikides või on tulemused siiski Läti konteksti põhised.

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2005–2008	University of Tartu, BA in Economics (cum laude)
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Work experience:

11/2016–	BIGBANK AS, modelling analyst
1/2013–1/2017	University of Tartu, School of Economics and Business Administration, Junior Research Fellow in the Chair of Economic Modelling
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6/2009–8/2009	practical training in ThyssenKrupp (in Germany)
10/2008–9/2011	University of Tartu, School of Economics and Business Administration, participating in different research projects

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2010–2016	Multivariate Statistics (MA level)
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2010–2013	Research and Data Analysis Methods in Economics (BA)
2011–2016	Statistical and Econometric Methods (BA level)
2012–2015	Practical Training (BA level)
2012–2013	Sample Surveys in Business (MA level)
2013–2016	Bachelor Seminar (BA level)

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01.01.08–31.12.11	Innovation indicators for catching-up countries
01.01.08–31.12.13	The path dependent model of the innovation system: development and implementation in the case of a small country
01.01.10–31.12.13	The impact of internationalisation on the innovativeness of firms
30.10.10–30.08.13	Elaboration of the methodology of register-based population and housing census
01.01.11–31.08.15	Research and Innovation Policy Monitoring Programme Working Package 4
01.03.12–10.09.12	Mapping of Estonia's service economy
01.01.15–30.09.15	Research: "The economic impact of research in the sectoral innovation systems of the technologies, which are rewarded in Estonia"

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Haridus:

2011–	Tartu Ülikool, doktoriõpe
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2010 kevad	Bologna Ülikool, magistriõpingud majandusteaduses
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2002–2005	Pärnu Ühisgümnaasium
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Võõrkeeled: inglise keel, saksa keel

Töökogemus:

2016–	BIGBANK AS, modelleerija
1/2013–1/2017	Tartu Ülikooli majandusteaduskond, majanduse modelleerimise nooremteadur
9/2011–1/2013	Tartu Ülikooli majandusteaduskond, majanduse modelleerimise assistent
6/2009–8/2009	praktika ettevõttes ThyssenKrupp (Saksamaal)
10/2008–9/2011	Tartu Ülikooli majandusteaduskond, lepingulised projektid

Peamised uurimisvaldkonnad: seos tootlikkuse ja innovatsiooni vahel, erinevad teadmussiirde kanalid, sealhulgas ettevõtete-ülikoolide koostöö, töötajate mobiilsus

Akadeemiline töö:
1) Õpetamine:

2010–2016	Mitmemõõtmeline statistika (magistriõpe)
2010–2016	Statistika (bakalaureuseõpe)
2010–2013	Uurimis- ja analüüsimeetodid majanduses (bakalaureuseõpe)
2011–2016	Statistilised ja ökonomeetrilised meetodid (bakalaureuseõpe)
2012–2015	Praktika (bakalaureuseõpe)
2012–2013	Valikuuringud ettevõtluses (magistriõpe)
2013–2016	Bakalaureuseseminar (bakalaureuseõpe)

2) Juhendamine

- magistritasemel (10 kaitsmist)
- bakalaureusetasemel (7 kaitsmist)

3) Osalemine teadusprojektides

01.01.08–31.12.11	Innovatsiooni indikaatorid konvergeeruvatele riikidele
01.01.08–31.12.13	Innovatsioonisüsteemi rajasõltuvust arvestava mudeli loomine ja rakendusmehhanismi väljatöötamine väikeriigi näitel
01.01.10–31.12.13	Rahvusvahelistumise mõju ettevõtete innovaatilisusele
30.10.10–30.08.13	Registripõhise rahva- ja eluruumide loenduse metoodika väljatöötamine
01.01.11–31.08.15	Teadus- ja innovatsioonipoliitika seire programmi seirevaldkond
01.03.12–10.09.12	Teenusmajanduse sektori kaardistamine
01.01.15–30.09.15	Uuring „Teadustöö majanduslike mõjude avaldumine Eestis premeeritud tehnoloogiaid hõlmavates sektoraalsetes innovatsioonisüsteemides“

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