UNIVERSIDADE BEIRA INTERIOR

University-Industry Cooperation from a business perspective: a European approach

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CHAVE MÓVEL

Dedicatory

To "MINES"...

To my husband and my M&M!

Thanks and Acknowledgment

In these first lines, I would like to thank some people who contributed to the realization of this study in a different but crucial way.

Therefore, I would like to thank my supervisor, Professor Cristina Fernandes, and my co-supervisor, Professor José Luís Abrantes, for always accompanying me and, at any time, with very assertive criticisms and suggestions decisive for the realization of my thesis. Thank you for the demand, patience, having believed in the final result of this work, and, above all, for the friendship that will surely last a lifetime.

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On the other hand, I cannot fail to mention my husband and daughters for their special and unconditional support. Thank you for understanding my tantrums, never doubting me, and understanding my absence. Thank you for being with me in good and bad times. To my parents for always being with me at all stages of my life.

Last but not least, to my GOD for the courage and strength he gives me each day... and for his victories!

My heartfelt thanks to all!

Abstract

Cooperation between University-Industry (U-I) has been an area of interest for parts of the industry, higher education institutions, and governments insofar as it allows the development of companies and countries. Several reasons lead to U-I cooperation: product and process innovation, knowledge transfer (KT), and technology transfer. We currently live in a context of globalization and constant technological evolution, where financial, economic, political, and social crises significantly impact everyone's lives, individuals and companies. Thus, innovation is a crucial factor in competitiveness. To this end, companies establish partnerships with various agents, including universities. Knowledge management, innovation, and competitiveness, whether business or regions and countries, have been topics of much research and interest in the literature. Despite the numerous studies, this area has much to be explored, which is very fragmented. Therefore, further investigations will be needed to contribute to developing scientific knowledge of the U-I cooperation.

The main objective of this research is to carry out a global analysis of the U-I cooperation process in the development of companies. Thus, it is analyzed the determinants considered crucial in cooperation, government role, and the impact of KT on the innovative capacities of companies. The study has the European space as its scope. Given the above, this dissertation will consist of 4 studies. The first is a systematic literature review (SLR) whose objective is to explore and describe the existing scientific literature on U-I cooperation and current and future trends within this theme. The results show that the analysis of the determinants that propitiate the U-I cooperation is fundamental and that the government plays a crucial role in the development of the U-I cooperation with the universities. Also, the KT obtained by U-I cooperation has a predominant impact on companies' innovation on it is products and processes.

Chapters 3, 4, and 5 adopted quantitative methodologies using the Community Innovation Survey (CIS) database analysis. Chapter 3 analyzed how the government plays an active role in creating knowledge and innovation through public funds. To this end, this study investigated the dynamics of relationships between Triple Helix agents, considering a business aspect. The analysis used STATA software to develop logistic regression models, and the results show that the government's role in U-I cooperation is fundamental. However, not all public funds have the same level of influence. Chapter 4 addressed the crucial determinants for U-I cooperation to develop, allowing

companies to achieve competitive advantages. This analysis uses STATA software to create logistic regression models. This study indicates that the size of companies, Research & Development activities (internal and external), exports, and obtaining public funds are determining factors for companies to establish U-I cooperation. Chapter 5 analyzes the role of KT in the innovative capacity of companies and the influence of absorptive capacity (AC) as a moderating variable. This study used SPSS and Hayes' PROCESS software to analyze the hypotheses proposed through the development of logistic regression models. The results show that national and international KT positively impacts the development of product and process innovation. On the other hand, AC is considered a moderating variable when U-I cooperation is with universities of the same country because it impacts the relationship between national KT and innovative capabilities. The same does not happen when U-I cooperation is with universities from another European Union (EU) country, especially in products.

The conclusions have important theoretical and practical implications. At the theoretical level, it identifies and fills gaps in the literature. On a practical level, it supports companies, policymakers, and universities in implementing measures that allow U-I cooperation under the best conditions, enabling companies to acquire new knowledge, skills, and advantages to grow and be competitive. Finally, future lines of investigation are exposed, as well as the limitations observed.

Keywords

U-I cooperation; community innovation survey; innovation; triple helix; knowledge transfer; determinants.

Resumo Alargado

A cooperação entre Universidade e Indústria (U-I) tem sido uma área de interesse por partes da indústria, das instituições de ensino superior, e também por parte dos governos na medida em que esta permite o desenvolvimento das empresas e também dos países. Os motivos que levam à cooperação U-I são vários: a inovação de produtos e processos, a transferência de conhecimento e a transferência de tecnologia. Vivemos atualmente num contexto de globalização e de constante evolução tecnológica, onde as crises financeiras, económicas, políticas e sociais, têm um impacto considerável na vida de todos, indivíduos e empresas. Assim, a inovação é considerado um fator chave de competitividade. Para tal, as empresas estabelecem parcerias com vários agentes, incluindo as universidades. A gestão do conhecimento, a inovação e a competitividade, quer empresarial quer das regiões e países, têm sido tópicos de bastantes pesquisas e interesse na literatura, demonstrando assim a relevância do tema. Apesar dos inúmeros estudos realizados, esta é uma área que tem muito por explorar e que se encontra muito fragmentada. Assim, serão necessárias mais investigações que permitam contribuir para o desenvolvimento do conhecimento científico da U-I cooperação.

Face ao presente enquadramento da problemática em estudo, foram desenvolvidas as seguintes questões de investigação:

1. Quais os aspetos e categorização da literatura relacionados com a cooperação U-I que têm sido estudados ao longo dos últimos anos?
2. Qual o papel do governo (fundos públicos) na criação de conhecimento?
3. Quais os fatores que influenciam a cooperação U-I?
4. Qual o efeito da transferência do conhecimento nas atividades inovadoras das empresas?
5. Qual o efeito moderador da capacidade de absorção na relação entre a transferência do conhecimento e a capacidade inovadora das empresas?

Tendo por base essas questões de investigação, foram propostos os seguintes objetivos:

1. Contextualizar a literatura existente relativamente à cooperação U-I;
2. Estudar a cooperação entre universidade-indústria-governo;
3. Identificar os fatores determinantes na cooperação U-I;
4. Analisar o efeito da transferência de conhecimento na capacidade inovadora das empresas bem como o efeito moderador da capacidade de absorção na relação entre transferência do conhecimento e a capacidade inovadora das empresas.

Este trabalho de investigação tem como principal objetivo realizar uma análise global ao processo de cooperação U-I no desenvolvimento das empresas, tendo por base uma perspetiva empresarial. Assim, pretende-se fazer uma análise aos fatores que são considerados cruciais na cooperação, ao papel do governo e ao impacto da transferência do conhecimento nas capacidades inovadoras das empresas. O estudo que se pretende realizar tem como âmbito o espaço Europeu. Perante o exposto, esta dissertação será constituída por 4 estudos. O primeiro tem por objeto uma revisão sistemática da literatura cujo objetivo consiste em explorar e descrever a literatura científica existente sobre a cooperação U-I e analisar as tendências atuais e futuras dentro desta temática. Para tal recorreu-se à recolha da literatura existente na base de dados *Web of Science* (WoS). Os 85 artigos selecionados na WoS foram analisados analiticamente e também com recurso ao software *VOSviewer*. Os resultados demonstraram que a análise dos determinantes que propiciam a cooperação U-I é fundamental, que o governo desempenha um papel primordial para que a indústria possa cooperar com as universidades e que a transferência do conhecimento obtida pela cooperação U-I tem um impacto preponderante na inovação de produtos e processos.

Os capítulos 3, 4 e 5 adotaram metodologias quantitativas recorrendo à análise da base de dados do *Community Innovation Survey* (CIS). No capítulo 3 analisou-se de que forma o governo tem um papel ativo na criação de conhecimento e inovação. Para tal, analisou-se a dinâmica das relações existentes entre os agentes da *Triple Helix*, tendo em linha de conta uma vertente empresarial. Para a análise em questão recorreu-se à utilização do software STATA. Assim, foram desenvolvidos modelos de regressão logística a fim de avaliar o impacto dos vários fundos públicos disponíveis na cooperação que as empresas estabelecem com os sgentes da Triple Hélix. Os resultados demonstraram que o papel do governo é fundamental, embora nem todos os fundos públicos tenham o mesmo nível de influência. Os fundos do governo central e da União Europeia são os mais significativos no processo de cooperação. O capítulo 4 abordou a temática dos determinantes que são considerados cruciais para que a cooperação U-I se possa desenvolver permitindo às empresas alcançar vantagens competitivas. Para tal, recorreu-se ao software STATA e à utilização de modelos de regressão logística. Os resultados deste estudo indicam que o tamanho das empresas, as atividades de Investigação & Desenvolvimento (interno e externo), as exportações e a obtenção de fundos públicos são fatores determinantes para que as empresas estabeleçam a cooperação U-I. O capítulo 5 analisa o papel da transferência do conhecimento na capacidade inovadora das empresas. Por outro lado, á avaliado também o papel da

capacidade de absorção enquanto variável moderadora. Para a análise em questão recorreu-se à utilização dos softwares SPSS e PROCESS, desenvolvendo modelos de regressão logística. Os resultados apontam que a transferência do conhecimento nacional e internacional tem um impacto positivo no desenvolvimento da inovação de produtos e de processos. Por outro lado, a capacidade de absorção é considerada uma variável moderadora quando a cooperação é desenvolvida com universidades do próprio país pois impacta a relação entre transferência do conhecimento nacional e as capacidades inovadoras. O mesmo não acontece quando a cooperação é com universidades de outro país da União Europeia, especialmente em termos de produtos.

No que respeita a limitações, a principal foi sem dúvida de não ter sido possível utilizar os dados de todos os países que fazem parte do CIS pois nem todos facultaram os dados que se pretendiam analisar, impedindo assim que os resultados dos vários estudos se tornassem mais representativos e abrangentes. Contudo, os resultados obtidos fortalecem a teoria e a prática sobre a cooperação U-I, a importância do governo e o impacto da transferência do conhecimento no processo inovador das empresas. As conclusões têm implicações importantes ao nível teórico e prático. A nível teórico, identificando e preenchendo lacunas encontradas na literatura. No que se refere a implicações práticas, este estudo poderá ajudar as empresas e os governos nas suas tomadas de decisão no sentido de os alertar para a importância da cooperação U-I, pois essa permite o desenvolvimento das empresas e consequentemente dos países. Por outro lado, também pretende sensibilizar as universidades no sentido de estas desenvolverem mais estudos e projetos, e de os divulgarem junto da sociedade, desenvolvendo assim a sua terceira missão. Por último expõem-se as propostas de linhas futuras de investigação, bem como as limitações observadas na mesma.

Palavras-Chave

Cooperação U-I; community innovation survey; inovação; triple helix; transferência do conhecimento; determinantes.

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Acronym List

AC	Absorptive Capacity
CIS	Community Innovation Survey
CT	Cooperation Theory
EU	European Union
EUROSTAT	European Statistical System
GBARD	Government budget allocations for R&D
GDP	Gross Domestic Product
HEI	Higher Education Institution
OECD	Organization for Economic Cooperation and Development
KBV	Knowledge Based View Theory
KT	Knowledge Transfer
R&D	Research & Development
SME	Small and Medium Enterprises
SPSS	Statistical Package for the Social Sciences
SLR	Systematic Literature Review
TH	Triple Helix
TRC	Theory of Resources and Capacities
U-I	University- industry
U-I-G	University-industry-government
WoS	Web of Science

Part I

Chapter 1. Introduction

1.1. Justification of the Investigation

Knowledge ownership is growing in the global economy context (Rubens, Spigarelli, Cavicchi, & Rinaldi, 2017). However, companies have limited resources and do not always have the necessary knowledge to innovate and compete in the markets (Un & Rodríguez, 2018). Therefore, there is a need to promote cooperation between companies and other partners, thus creating working groups that impact the growth of companies (Fernández-López, Calvo, & Rodeiro-Pazos, 2019; Stejskal, Meričková, & Prokop, 2016). In this way, companies will achieve knowledge based on innovation and specific skills to enhance their potential (Fernández-López et al., 2019).

Universities have emerged as essential actors in innovation (Di Maria, De Marchi, & Spraul, 2019). The adoption of modern management practices should be a priority for companies because it can be an effective way to achieve high standards of collaboration with universities, promoting innovation and taking advantage of the competitive, economic, and sustainable benefits derived from it (Aiello, Cardamone, & Pupo, 2019). Companies that seek cooperation agreements to explore external sources of knowledge intend to have access to new technologies or markets, benefiting from economies of scale in R&D (Research and Development) and/or production, share risks (Fischer & Varga, 2002), and create innovations in products and processes (Stejskal et al., 2016). The U-I (University-Industry) cooperation is a source of growth (Aiello et al., 2019; Berbegal-Mirabent, Sánchez García, & Ribeiro-Soriano, 2015; Hunady, Orviska, & Pisar, 2018), as it allows the sustainability of companies that come from innovation (Atta-Owusu, Fitjar, & Rodríguez-Pose, 2021; Jones & Corral de Zubielqui, 2017). Thus, it is essential to understand the factors that drive or inhibit U-I cooperation (Galán-Muros & Plewa, 2016).

Universities perform three distinct functions: 1) they are a generator of human capital, namely through the training they offer, instructing future researchers; 2) as entrepreneurs in the general process of scientific research; 3) the so-called "third mission" as a generator of industrial innovation with the function of producing knowledge directly applicable to industrial production (Ashraf, Hou, Kirmani, Ilyas, Zaidi, & Ashraf, 2018; Schartinger, Rammer, Fischer, & Fröhlich, 2002). A significant aspect of this process is the multidisciplinary nature of knowledge production that

allows interaction between science, technology, and government policies in developed and developing countries (Giuliani & Arza, 2009).

U-I cooperation has aroused the interest of governments of industrialized countries as it allows economic development (Chen, Wu, & Yang, 2016). It also contributes to social inclusion, creating skilled jobs, and increasing companies' competitive advantages (Giuliani & Arza, 2009). However, U-I cooperation faces significant challenges since the universities play roles in teaching and creating new knowledge, and companies want to capture valuable knowledge that leverages their competitive advantage (Bruneel, Este, & Salter, 2010). Thus, companies that cooperate with universities perform more positively. Therefore, it will be necessary to adopt public policies to support this cooperation (Stejskal et al., 2016). The need for a governmental structure to promote the alignment of U-I cooperation objectives, solve problems, and establish clear rules for all stakeholders is fundamental (Alves, Quelhas, Da Silva, & Lameira, 2015; Eom & Lee, 2010). The Triple Helix (TH) Model structures the relationships between three institutional spheres: university-industry-government (U-I-G). According to the TH model, universities need to be directly linked to industry to maximize knowledge and its transference, thus emphasizing their "third mission": helping economic development beyond teaching and research (Etzkowitz & Leydesdorff, 2000). For Park & Leydesdorff (2010), the TH is an indicator that examines the effectively established relationships between U-I-G to work together. This cooperation is a critical factor for the growth of regional business ecosystems (Brem & Radziwon, 2017). Thus, government policies play a crucial role in promoting U-I cooperation through public funds to encourage private research and development (Aiello et al., 2019; Badillo, Galera, & Serrano, 2017).

The search for knowledge from external sources has allowed companies to improve their innovative capabilities (Bellucci & Pennacchio, 2016). Companies can obtain different benefits through knowledge transfer (KT), namely the creation of R&D projects, consultancy and technical assistance, technology diffusion, promotion of international cooperation (Badillo et al., 2017), patent counting, R&D innovations (Szücs, 2018), and new ideas and complex innovations (Fontana, Geuna, & Matt, 2006). The importance of KT among U-I is unquestionable (Aiello et al., 2019) concerning innovation and technological changes (Schartinger et al., 2002). Universities' entrepreneurial capacities and scientific qualities are vital when transferring knowledge to companies. On the other hand, companies with a strategic vision of innovation, high technology companies, and high absorption capacities will be more likely to capture the knowledge transmitted by universities (Bellucci &

Pennacchio, 2016). Despite the increase in U-I cooperation, this interaction has not reached its full potential. It is, therefore, necessary to introduce resources through government incentives to help overcome the perceived barriers in this relationship (Alves et al., 2015). This area has been of interest to governments and an objective pursued by countries to increase their competitiveness (Ferreira, Fernandes, & Ratten, 2018).

The literature includes various studies on U-I cooperation. They focus on topics as varied as the types of cooperation (Bekkers & Bodas Freitas, 2008; Leydesdorff & Park, 2014; Perkmann et al., 2013), the factors influencing this cooperation (Berbegal-Mirabent et al., 2015; Lee, 1996; Schartinger et al., 2002), the influence of the public funds in the cooperation process (Alarcón & Arias, 2018; Badillo & Moreno, 2016; Busom & Fernández-Ribas, 2008; Hernández-Trasobares & Murillo-Luna, 2020; Junior & Odei, 2018; Prokop & Stejskal, 2018), and the effects of KT on innovation (Escribano, Fosfuri, & Tribó, 2009; Franco, Haase, & Fernandes, 2014; Kostopoulos, Papalexandris, Papachroni, & Ioannou, 2011). However, there are still gaps in the literature that could demonstrate the importance of continuing to study U-I cooperation. Given the relevance of this topic in the current world economic situation, the present thesis intends to contribute to the deepening of scientific knowledge on the subject under study. So, this thesis aims to understand better the importance of U-I cooperation, more specifically related to business innovation. Thus, it will analyze the importance of government in the cooperation process through TH, the determining factors for U-I cooperation, and KT's influence on companies' innovative capacities.

1.2. Unit of analysis and conceptual model

The present research analyzed the European context. To develop the empirical work mentioned in Chapters 3, 4, and 5, the most appropriate method for this investigation would be the use of secondary data. Several authors have resorted to the CIS (Community Innovation Survey) database to develop their research (Atta-Owusu et al., 2021; Escribano et al., 2009; Goel, Göktepe-Hultén, & Grimpe, 2017; Laursen & Salter, 2006; Mascarenhas, Marques, Ferreira, & Galvão, 2022; Moura, Madeira, & Duarte, 2020; Prokop & Stejskal, 2018; Segarra-Blasco & Arauzo-Carod, 2008).

The CIS database allows access to data about companies' information with quality and reliability. Thus, this thesis resorted to using the secondary database of the CIS 2016 because it corresponds to the needs and requirements to analyze U-I cooperation in

this period in Europe. It presents a harmonized questionnaire of European Union (EU) member states and includes EU science and technology statistics, the main statistical survey on innovation in companies. It contains different types of information about the cooperation of companies. The CIS questionnaires were developed based on extensive pilot tests and pre-tests and under EUROSTAT – European Statistical System supervision, based on the Oslo Manual's conceptual framework (OECD, 2005). It was applied in different European countries and between companies from diverse industrial sectors, including services, construction, and manufacturing, thus allowing for interpretability, reliability, and validity of the research. The CIS 2016 include dates from 15 European countries: Germany, Cyprus, Slovenia, Slovakia, Spain, Estonia, Hungary, Italy, Ireland, Latvia, Lithuania, Norway, Portugal, Czech Republic, and Romania.

Estonia has the highest percentage of companies cooperating on innovation, with 57% in 2017 and 2019, having suffered a decrease in 2021, with 39%. Slovakia, Lithuania, and Slovenia also show a high percentage in 2017 and 2019, with values greater than 40 percent, having suffered a decrease in 2021. Germany, Hungary, Ireland, Italy, Norway, and Portugal show an increase in the percentage of cooperation from the year 2019 to 2021, as is possible to seen in figure 1.1. However, figure 1.1 does not include information about Cyprus and Romania because it is unavailable.

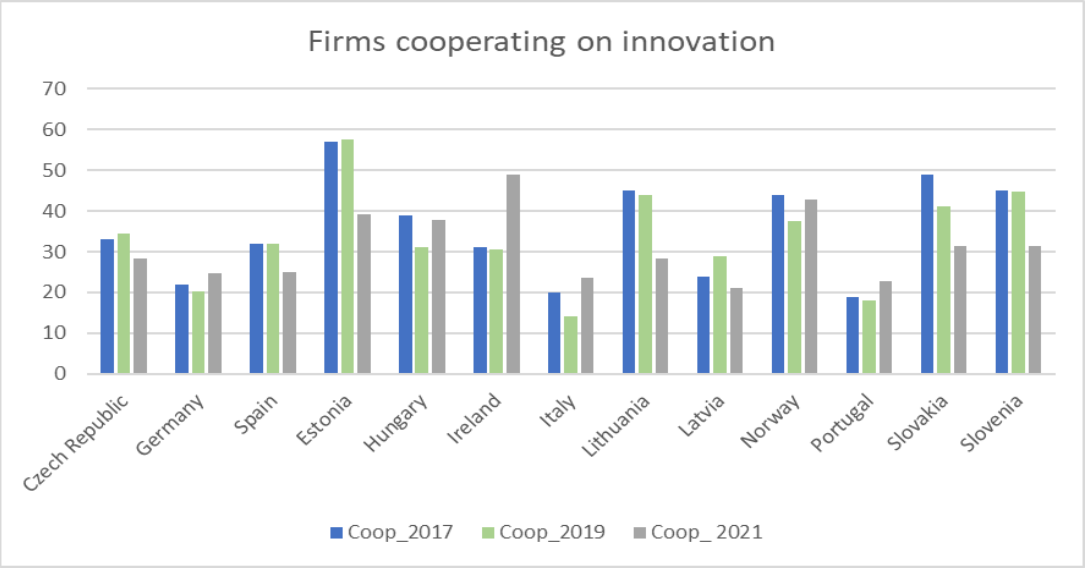


Figure 1.1 - Firms cooperating on innovation

Source: Adapted from OECD Innovation Stas, 2002 (http://oe.cd/inno-stats)

Germany, Ireland, Italy, and Portugal have increase cooperation with Higher Education Institutions from 2019 to 2021. Ireland has the highest percentage of cooperation with universities, with around 25%. Countries like Spain, Italy, Lithuania, Ltvia, and Norway

have cooperation percentages with universities below 10% in 2021. Also, in this case, the data are not available to Cyprus and Romania.

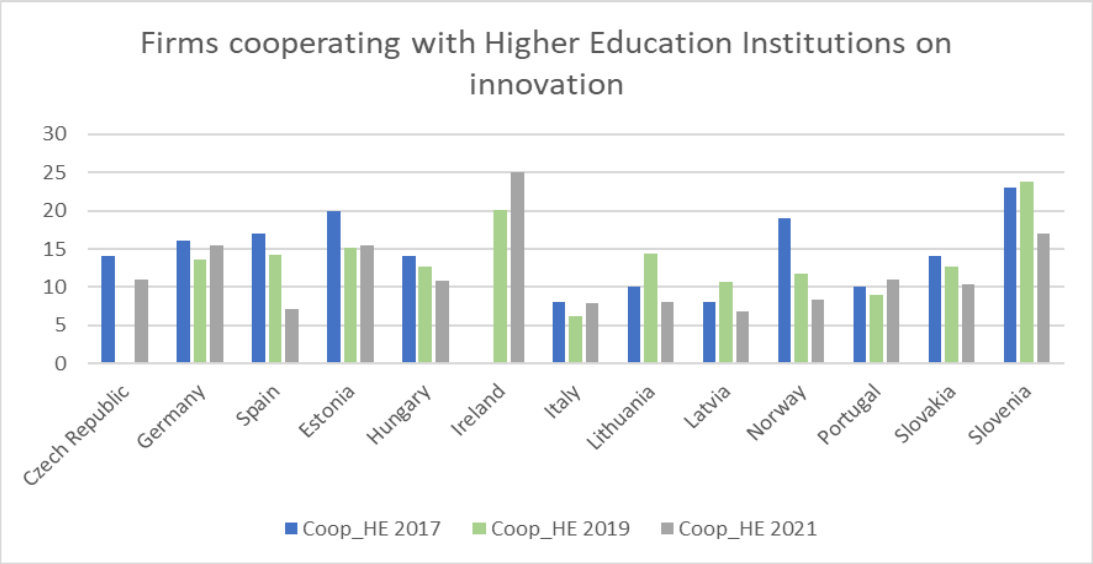


Figure 1.2 - Firms cooperating with higher education institutions on innovation
Source: Adapted from OECD Innovation Stas, 2002 (http://oe.cd/inno-stats)

Although the situation is uneven between countries, the figures 1.1 and 1.2 reflect how there is still important to promote U-I cooperation, facilitating the KT generated in universities to companies and the rest of society.

European Government´s budget allocations for R&D (GBARD) cover government-funded R&D carried out in government establishments and government-funded R&D in commercial enterprises, private non-profit organizations, and higher education. Figure 1.3 refers to the percentages of Government budget allocations for R&D (GBARD) for 2010 and 2020 (EUROSTAT, 2022).

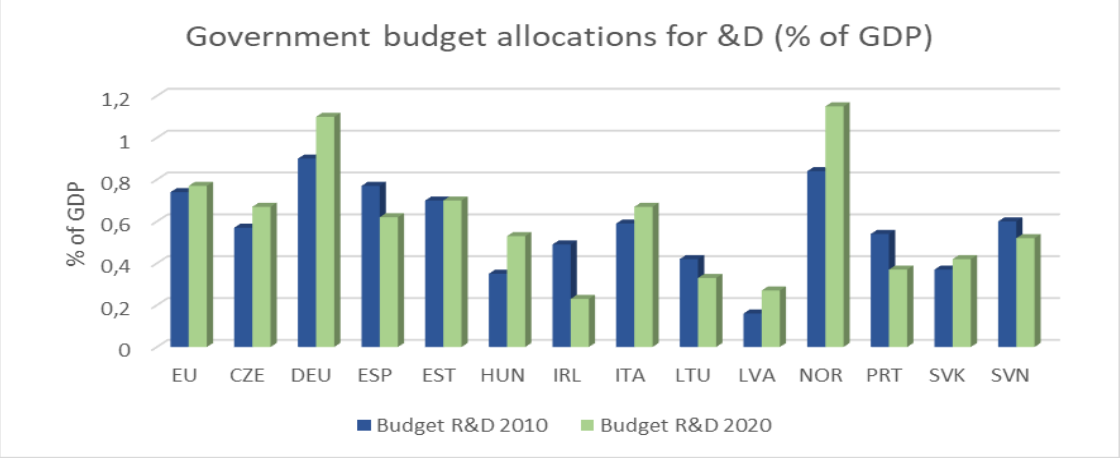


Figure 1.3 - Government budget allocations for R&D, 2010-2020 (% of GDP)
Source: Adapted from EUROSTAT, 2002 (http://ec.europa.eu/eurostat/statistics-explained/)

The total government budget allocations for R&D across the EU in 2020 was 0.8% of GDP (Gross Domestic Product), equivalent to €102,787 million. Also, in the analyzed countries, only Spain, Ireland, Lithuania, and Portugal present values in 2020 lowest than those available in 2010. The government of Norway provided around 0.84% in 2010 and 1.15% of GDP in 2020, giving rise to an increase in R&D funding of 0.31%, making it the country that had the most growth among the analyzed countries. Germany is a country with high R&D funding, providing about 0.9% of GDP in 2010 and 1.1% in 2020, giving rise to 0.2%. This analysis of the information included in figure 1.3 demonstrates the great concern of governments in need to invest and develop more R&D.

Considering the importance of the topic, the main objective of this thesis is to study U-I cooperation, more specifically that is related with business innovation. Thus, it will analyze the importance of government in the cooperation process through TH, the determining factors for U-I cooperation, and the influence of KT on the innovative capacity of companies.

The research carried out is developed in sequential stages of development, which are interrelated and interconnected. Thus, this investigation contextualized the existing literature regarding U-I cooperation in an initial phase. Subsequently, this thesis studied U-I-G cooperation and identified the determining factors in U-I cooperation. The final objective was to analyze the impact of KT on the innovative activities of companies and the moderating effect of AC on the relationship between the variables.

The analysis model of the thesis is that of the scheme shown in figure 1.4.

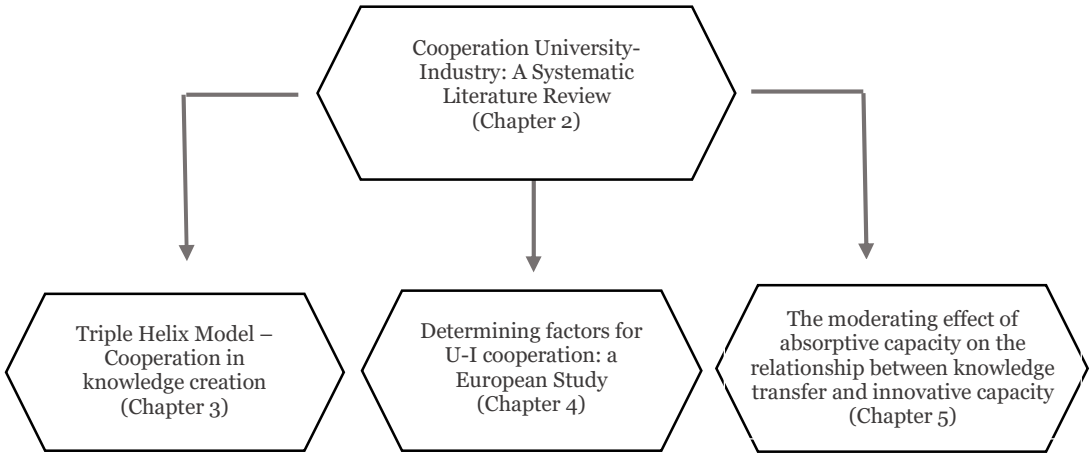


Figure 1.4 - Conceptual model of the thesis

Through the analysis of table 1.1, a better understanding of the connection between the questions and the research goals is possible.

Table 1.1 - Correspondence between the questions and the objectives of the investigation

		Questions				
		What aspects and categorization of U-I cooperation literature have been studied over the last few years?	What is the role of government (public funds) in creating knowledge?	What factors influence U-I cooperation?	What is the effect of KT on the innovative capacity of companies?	what is the moderating effect of absorptive capacity in the relationship between knowledge transfer and innovation?
Goals	Contextualize the existing literature regarding U-I cooperation	Chapter II	Chapter III	Chapter IV	Chapter V	Chapter V
	Study U-I-G cooperation		Chapter III			
	Identify the determining factors in U-I cooperation			Chapter IV		
	Analyze the effect of knowledge transfer and the moderating effect of absorptive capacity on companies' innovative activities				Chapter V	Chapter V

1.3. Methodology

Epistemology and methodology constitute two distinct and complementary disciplinary fields. Epistemology is interested in the nature, sources, and validity of knowledge, while method addresses research practices (Almeida & Pinto, 1986). The philosophical classification of research is important because it will allow the researcher to define the best research design, namely the typology of data to be used, collected, and analyzed (Easterby-Smith, Thorpe, Jackson, 2008). The present research fits within the scope of internal epistemology, defended by Bernardo Bolzano. This type of research is born from a specific scientific area and is associated with a high degree of specialization. Science is questioned from a particular point of view, in this specific case, the investigation focuses on the phenomenon of U-I cooperation, intending to question the foundations, structure, and results related to this area.

According to Marconi & Lakatos (2017), there are four research approach methods: the inductive, the deductive, the hypothetical-deductive, and the dialectical method. The inductive method starts with particular findings for laws and theories, while the deductive method starts with laws and theories and predicts the occurrence of specific phenomena. The hypothetical-deductive method begins with the perception of a knowledge gap and the formulations of hypotheses. Finally, the dialectical method penetrates the world of the phenomenon through its reciprocal action, the contradiction inherent in the phenomenon, and the dialectical change that occurs in nature and society.

In this study, the methodology used will have a predominantly deductive character since it starts from the general to the particular. The research project is based on models built from the accumulated results of previous investigations, placing research hypotheses (Blachowicz, 2009). Thus, the research will be developed according to the existing theories on U-I cooperation and intends to corroborate the propositions and hypotheses proposed.

According to Popper's (1999), the researchers should look at his objective, taking into account the observation of the phenomenon to interpret it based on a theory. Since the U-I cooperation has been the object of study over the years from different perspectives, and as the present research intends to analyze research hypotheses, it adopts the method of conjunctures and refutations, which will allow the progress of knowledge scientific (Popper, 1999).

1.3.1. Research methodology

It is essential to see knowledge from different perspectives and consciously know that this is an alterable and not static phenomenon (Popper, 1999). For Bachelard (1990), the "spirit is old", so it is essential to oppose opinion to obtain knowledge, and only in this way will science be subject to improvement. The meaning of the problem or question associated with the scientific spirit is what generates knowledge. For Bachelard (1996), the first step in creating science is formulating the research problem built from scientific knowledge. On the other hand, the researcher must oppose their opinion to do science, which is considered an epistemological obstacle. In this way, scientific progress contributes to the correct definition of the problem.

All research papers must precisely define the research methodology followed. In qualitative research methodology, the theory is present, but it is not necessarily a

starting point, and theoretical assumptions are discovered as the research progresses. The formulation of the theory and the reformulation of hypotheses happen as the data are analyzed (Brannen, 2005). Regarding the quantitative methodology, the researcher starts his investigation from existing theoretical knowledge or previous empirical results to formulate hypotheses to be operationalized and tested, with empirical data being the predefined data collection instruments (Brannen, 2005). The choice of this research method is justified by the fact that the aim is to explain a specific phenomenon (Sánchez-Algarra & Anguera, 2013).

This investigation will be descriptive since it intends to focus on the process and understand a mechanism or relationship, in this case, the U-I cooperation. Regarding the methodology used, a mixed approach was chosen, alternating between systematic literature review and quantitative methods, using descriptive statistics and logistic regression. Thus, according to (Feyerabend, 1993), methodological pluralism is based on different research methodologies.

Table 1.2 summarizes the methodology adopted in each chapter.

Table 1.2 - Systematization of the methodology adopt

Chapter	Methodology
Chapter 2	Systematic Literature review – VOSviewer 1.6.13
Chapter 3	Quantitative – STATA 14.2, developing logistic regression
Chapter 4	Quantitative – STATA 14.2, developing logistic regression
Chapter 5	Quantitative – SPSS 27 and PROCESS 4.0, developing logistic regression

1.3.2. Approaches in the chapters

According to Popper (1999), theory must precede observation, so this thesis presents a literature review; after that, the objectives of the sudsequent chapters were defined. Thus, the second chapter is a Systematic Literature Review (SLR) that serves as a theoretical reference for the remaining chapters. Its theme is the cooperation between U-I and aims to understand and analyze the related aspects studied in recent years and categorize the existing literature. This SLR will follow a five-step approach as described by Denyer & Tranfield (2009): (1) formulate one or more research questions; (2) locate studies; (3) select and evaluate studies; (4) analyze and synthesize studies and (5) report and use the results. The SLR uses the Web of Science (WoS) database to be

considered the most prestigious database with the attention and trust of leading academic and research institutions (Gasparyan, Ayvazyan, & Kitas, 2013b). The research used the words "cooperation", AND "university-industry" AND "Innovation" as a topic. The search conducted found 280 articles. After applying the inclusion criteria, namely, articles published within the research area of Business Economics and written in English, 109 articles remained to be analyzed. The VOSviewer 1.6.13 software was applied to the research to build and visualize bibliometric maps and determine clusters and respective references (Boyack & Klavans, 2010; Kessler, 1963).

The empirical analysis of the remaining chapters (3, 4, and 5) uses data obtained from the CIS, which provides information about companies' innovations in different European countries. CIS information used was the characteristics of the companies, the sources of finance, and the partners with which they cooperate. Data were collected from all European countries that responded to the CIS questionnaire, except Cyprus. The studies use, for data analysis, SPSS 27.0 software (Statistical Package for the Social Sciences) through the development of logistic regression models. The objective is to examine the model that best fits to describe the relationship between a dependent dichotomous variable and a set of independent variables (Harrell, 2015). Logistic regression allows modeling the occurrence in probabilistic terms, and the logical model allows evaluating the significance of each of the independent variables in the model (Marôco, 2018).

In chapter 3, the objective will be to study the U-I-G cooperation, realizing how the government has an active role in creating knowledge and innovation. Thus, it will be possible to verify the significance and relevance of the Triple Helix model, considering the business perspective. Chapter 4 intends to identify the determining factors that allow and influence U-I cooperation and how the companies that are more likely to cooperate with universities are characterized. In addition to using logistic regression models to assess KT's influence on companies' innovative activities, the last chapter also used the PROCESS 4.0 software to evaluate the moderating impact of AC on the relationship between KT and innovative activities.

1.4. Thesis Contributions

This research aims to understand better the importance of U-I cooperation, more specifically related to business innovation. In this way, each study (chapters 2, 3, 4, and 5) fill gaps identified in the literature. It also presents results on the importance of

governments for U-I cooperation, identification of factors considered decisive for U-I cooperation, KT's influence on companies' innovative activities, and the moderating role of AC in the relationship between KT and innovative activities.

Chapter 2 develops an SLR, and the main contribution of this study was the survey and systematization of studies in this area, which allowed the identification of four clusters: 1) Triple Helix; 2) Knowledge Transfer; 3) Determinants of Cooperation; and 4) Strategic Alliances. The present study aims to understand state of the art in this field and the respective trends in this research area. Thus, and through bibliometric techniques, this SLR made it possible to identify what has already been addressed regarding the topic under study, identify the main knowledge deficiencies, and define directions for future studies. On the other hand, the research presents a conceptual model that contributes to the future of the theme. Finally, it allowed the introduction of the remaining empirical research.

The study in Chapter 3 offers a view of the links companies develop with TH, namely other companies, universities, and governments. These relationships were analyzed, taking agents located in the same country and agents from another EU country. This work contributes to the theory by analyzing the influence and importance of public funds (local, government, and EU) in the various cooperation's between TH agents. However, it was possible to verify that not all have the same level of influence. It also contributes by showing that the government can have a more active contribution in establishing the cooperation processes of companies.

Chapter 4 contributes to a deeper understanding of the essential determinants for companies to establish U-I cooperation. On the other hand, it allows for a more comprehensive view since the analysis considered companies' cooperation with universities of the same country, from the European Union (EU) or another country outside the EU. This work contributes to better empirical knowledge about the determinants that drive U-I cooperation. It was possible to verify that the size of the companies, the development in R&D, the accomplishment of exports, and the access to public funds are essential and significant determinants for U-I cooperation. On the other hand, the acquisition of machinery and training programs are not critical factors. It contributes to governments and universities by identifying the characteristics of companies that are more likely to cooperate with universities, making a comparative analysis in terms of proximity.

In chapter 5, the study analyzes the impact of KT on the development of companies' innovative capacity. It also examines the influence of AC as a moderating variable. It

was possible to verify that KT has a significant impact on the innovative capacity of companies. On the other hand, it was possible to confirm that the AC should be regarded as a moderating variable when KT is national since it impacts the relationship between KT and innovative activities - product and process. However, when the KT is international, AC does not significantly affect the creative capacities of companies, essentially in products. In addition to contributing to a deepening of knowledge in this area, it also identifies the influence of AC that may allow for a better and more effective U-I cooperation.

Cluster 4 called "Strategic Alliances" was not analyzed individually but in an aggregated and complementary way to chapters 3, 4, and 5. U-I cooperation is considered a strategic alliance by itself and, when supported correctly, namely through public funds, can bring benefits to all agents involved. In addition, it allows the growth of universities and companies through the transfer of knowledge and technology, achieving innovation and, therefore, countries' development.

In short, and given the relevance of this topic, this research thesis aims to contribute to the existing literature on the importance of U-I cooperation, more specifically related to the business perspective. It also contributes by understanding the role that government plays in U-I cooperation, characterizing the companies that cooperate the most, and identifying the importance of KT in the innovative capacity of companies and the impact of AC as a moderating variable. On the other hand, this thesis uses the European CIS database, which contains extensive information about companies from 15 EU countries, allowing the development of studies that permit a broader view of the reality studied through a comparative analysis between partners from the same country and another EU country.

1.5. Thesis Structure

The thesis will consist of three parts. The first part contains the introduction that provides a transversal overview of the literature, alluding to the set of chapters that make up the body of the thesis, detailing the objectives and research questions, the units of analysis, and the underlying methods. The second part consists of four chapters, one SLR, and three empirical studies. Each chapter develops a specific study, which can be read individually. The third part will approach the final considerations, implications, contributions, and future lines of research.

The thesis will follow the structure presented in Figure 1.5.

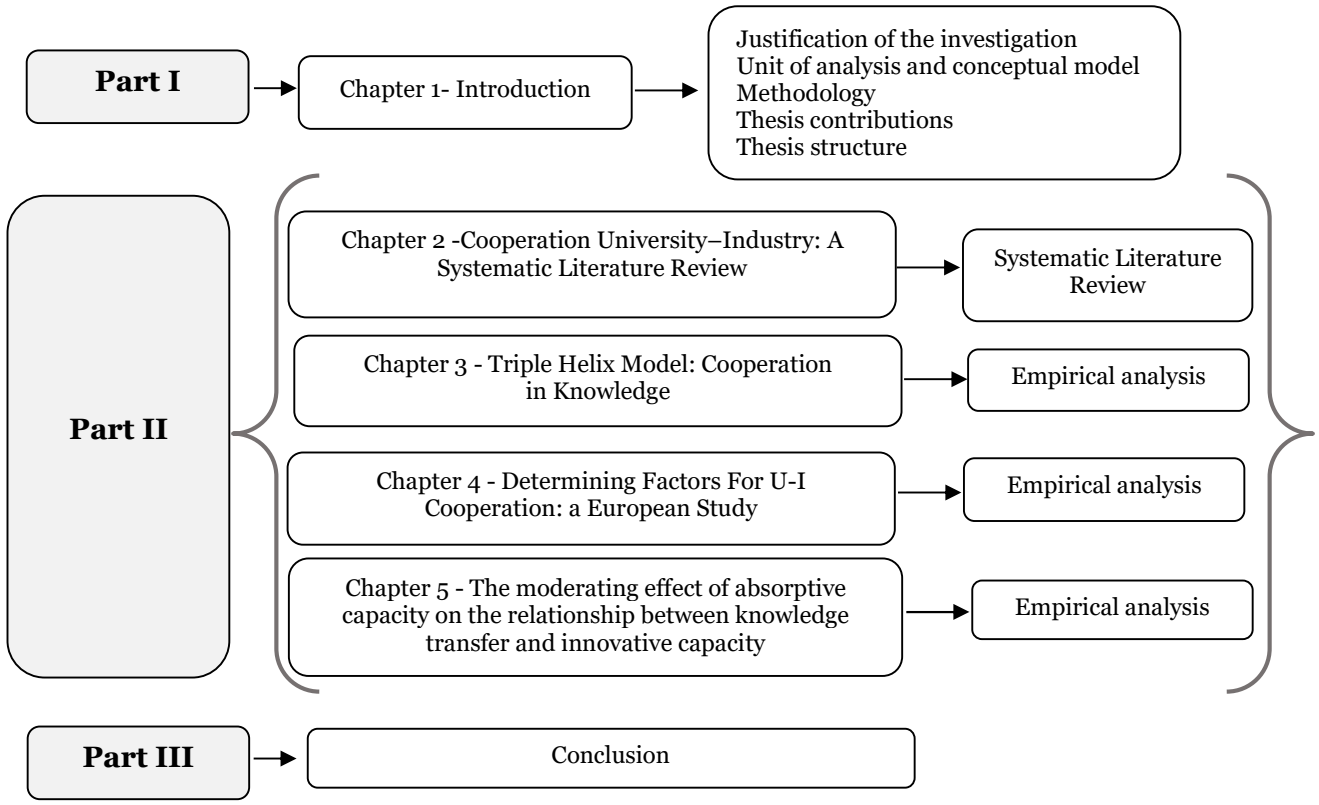


Figure 1.5 - Structure of the thesis

Table 1.3 presents correspondence between the chapters of this thesis and the published articles.

Table 1.3 - Published thesis chapters

Chapter	Publication
2 - Cooperation University–Industry: A Systematic Literature Review	*Figueiredo, N., & Fernandes, C. (2020). Cooperation University–Industry: A Systematic Literature Review. International Journal of Innovation and Technology Management, 17(08), 2130001.* (WOS: ESCI; Scopus: Q3; ABS: 1) *https://doi:10.1142/S0219877021300019*
3 - Triple Helix Model: Cooperation in Knowledge	de Lima Figueiredo, N., Fernandes, C. I., & Abrantes, J. L. (2022). Triple Helix Model: Cooperation in Knowledge Creation. Journal of the Knowledge Economy, *(*2020 JCR: 1.964 (Q2); ABS-1; Scimago: Q2) https://doi.org/10.1007/s13132-022-00930-1
4 - Determining Factors For U-I Cooperation: a European Study	Review process: International Journal of Entrepreneurship and Innovation (WoS - ESCI - Emerging Sources Citation; ABS-2; Scimago: Q2)
5 - The moderating effect of absorptive capacity on the relationship between knowledge transfer and innovative capacity	Submitted to Journal of Management and Organization (2020 JCR: 4.139 (Q2); ABS: 2; Scimago: Q2)

Part II

Chapter 2. Cooperation University-Industry: A Systematic Literature Review

Abstract

Knowledge and its transference are increasingly viewed as key factors of companies' competitiveness. This research aims to analyze how knowledge transfer occurs between the higher education sector and the companies. Although there has been an increase in research related to University-Industry (U-I) cooperation, the existing literature is still relatively fragmented and lacks a comprehensive view. In this way, this study aims to fill this gap by reducing the existing gap in the literature. Thus, this study aims at identifying the different trends and themes prevailing in the literature on U-I cooperation. Through a systematic literature review, using a bibliometric analysis, we identify four themes: (1) Triple Helix, (2) Knowledge Transfer, (3) Determinants of Cooperation, and (4) Strategic Alliances.

This research makes several important contributions: this review helps highlight not only what the previous literature has analyzed about U-I cooperation and prepares the ground for the second wave of research on this topic, synthesizing the main gaps in knowledge and the emerging trends in studies. Another contribution is the challenges of several prevailing theoretical/conceptual assumptions in U-I cooperation and offers new theoretical/conceptual perspectives that may shape future research on this topic. Last but not least, the paper defined a roadmap for a future research agenda by proposing multiple directions that can open new avenues for future research and the construction of relevant and appropriate theories for measuring the contributions of U-I cooperation.

Keywords: Cooperation university-industry, innovation, systematic literature review.

2.1. Introduction

In the current globalization and knowledge-based economies scenario, companies are forced to establish partnerships to become more competitive, achieving knowledge based on innovation and specific skills that highlight their potential (Fernández-López et al., 2019). The knowledge generated in universities and the flow of trained people

inserted in the economy's productive structure is understood as a prerequisite for technological and economic development (Bodas Freitas, Marques, & Silva, 2013). In this context, companies seek with universities to acquire new ideas, develop new capacities, access the latest academic research, access government funding, and a reduction in costs in I&D (Perkmann et al., 2011).

Cooperation between university and industry (U-I) is recognized as an essential pillar of economic development, contributing to social inclusion, creating qualified jobs, and increasing companies' competitive advantages (Bercovitz & Feldman, 2006; Giuliani & Arza, 2009). U-I cooperation has to do with all the interactions that occur between any institution in the higher education system and industry whose objective is to stimulate the exchange of technology and knowledge (Bekkers & Bodas Freitas, 2008; Bercovitz & Feldman, 2006), and there was an increase in pressure for this cooperation (Giuliani & Arza, 2009). For the industry, pressures arise due to constant technological changes, shorter product life cycles, and intensified global competitiveness (Wright, Clarysse, Lockett & Knockaert, 2008). For universities, the pressure is on acquiring new knowledge, cost reduction, and financing problems (Hagen, 2002).

Some studies aim to understand the role of knowledge exchange and cooperation between U-I, namely concerning innovation and technological changes (Schartinger et al., 2002). Universities contribute to industrial innovation through technological development because it enhances a variety of interactions that are not restricted to specific industries and fields. On the contrary, many scientific disciplines and almost all sectors of economic activity exchange knowledge (Schartinger et al., 2002). The importance of knowledge transfer between U-I is unquestionable (Aiello et al., 2019). According to Schartinger et al. (2002), universities and industries use a variety of channels in the knowledge transfer process. The channels used vary according to the intensity of the established personal relationships, the type of knowledge that is transferred, and the flow of knowledge. On the other hand, trust between partners is a crucial factor for cooperation to occur. For Eom & Lee (2010), the intellectual property right of each sector is one of the characteristics that affect the relations established between U-I.

The transfer of knowledge between U-I occurs at various levels, namely the generation of R&D projects, consultancy and technical assistance, diffusion of technology, promotion of international cooperation (Badillo et al., 2017), and complex new ideas and innovations (Fontana et al., 2006). In the case of successful innovations, cooperation with universities or research centers tends to be more associated with

product innovation than with process innovation and the creation of patents (Eom & Lee, 2010). Companies are willing to cooperate with universities to benefit from teachers' and students' knowledge, saving costs (Eom & Lee, 2010). If companies give importance to cooperation and information publicly available from universities, they will be able to increase the productivity of their innovation activities (Badillo et al., 2017). Schartinger et al. (2002) emphasize the importance of U-I cooperation, stating that companies depend heavily on the progress of science and technology.

U-I cooperation is seen as a source of growth because it encourages knowledge transfer, boosting innovation and the performance of companies. Thus, studying and knowing the determinants that allow this cooperation is crucial (Aiello et al., 2019). For example, Schartinger et al. (2002) studied the importance of the sector of activity, arguing that the U-I link is more important in industries based on science and technology; Bellucci & Pennacchio (2016) examined the transnational differences in the characteristics of innovation systems and the role of universities; Lee (1996) explored the relationship between U-I according to several variables and where he can conclude that seniority is one of the relevant factors of scientific prestige; another determinant that has been the object of study to understand cooperation between U-I is the size of the company (Badillo et al., 2017; Fontana et al., 2006).

A significant aspect of this process is the multidisciplinary nature of knowledge production that allows interaction between science, technology, and government policies in developed and developing countries (Giuliani & Arza, 2009). Hence, the central need for a government structure to promote the alignment of cooperation objectives between U-I, solve problems, and establish clear rules for all interested parties (Alves et al., 2015).

The Triple Helix (TH) Model is structured around the relationships between three institutional spheres: university-industry-government (U-I-G) (Etzkowitz & Leydesdorff, 2000). According to this model, universities need to be directly linked to industry to maximize knowledge and knowledge transfer, helping with economic development beyond teaching and research (Etzkowitz & Leydesdorff, 2000). For Park & Leydesdorff (2010), TH is an indicator that should be used to examine the effectively established relationships between U-I-G so that they can work together. Thus, government policies play a key role in promoting U-I cooperation (Perkmann et al., 2011), namely through public funds to encourage research, enable private development (Aiello et al., 2019; Badillo et al., 2017), and encourage regional technological development (Chen et al., 2016; Johnson, 2008).

Despite the increasing U-I cooperation, this interaction has not yet reached its maximum potential. It is then necessary to introduce resources through government stimuli that will help overcome the perceived barriers in this relationship (Alves et al., 2015).

For some authors, the low rate of collaboration with universities and research centers results in the little awareness by Small and Medium Enterprises (SMEs) about the real possibilities offered by universities (Badillo et al., 2017). However, although few, there are studies that argue the opposite, claiming that small companies tend to be more prone to cooperation because they face a lack of internal, financial resources, R&D capacity, or even facilities (Eom & Lee, 2010). The adoption of modern management practices should be a priority for companies as it can be an effective way of reaching high standards of collaboration with universities, promoting innovation, and taking advantage of the rapid economic and sustainable competitive advantages that can result from that (Aiello et al., 2019).

The relationship between U-I has been widely described in the literature (Mascarenhas, Ferreira, & Marques, 2018; Perkmann et al., 2013; Sjöö & Hellström, 2019; Vick & Robertson, 2018) and several Systematic Literature Reviews (SLR) were found. Sjöö & Hellström (2019) identified seven main factors that stimulate U-I's collaborative innovation: resources, university organization, comprehensive functions, collaborative experience, culture, the centrality of status, and environmental context. For Vick & Robertson (2018), the mechanisms and means used for U-I cooperation depend on the motivations and barriers that are consequences of the social and political factors that arise in the collaboration between the agents. Thus, they identified four central measures related to U-I collaboration: motivations, activities, barriers, and results. Rybnicek & Königsgruber (2018) prepared a systematic review of the literature on the factors that affect U-I cooperation, presenting the significant factors in four categories: institutional, relationship, production, and structural factors. Perkmann et al. (2013) developed research that aimed to analyze how academic involvement differs from commercialization (exploiting patented inventions). On the other hand, they identified the individual, organizational and institutional antecedents and consequences of academic involvement and then compared the antecedents and consequences of commercialization.

So far, approaches to the systematic review of quantitative literature in the context of U-I studies are limited, especially when it comes to capturing the latest developments in the field (Davey, Rossano, & van der Sijde, 2016; Mascarenhas et al., 2018; Meyer,

Grant, Morlacchi, & Weckowska, 2014; Perkmann et al., 2013; Skute, Zalewska-Kurek, Hatak, & de Weerd-Nederhof, 2019; Teixeira & Mota, 2012). As Schmidt & Hunter (2004) argue, this limitation is surprising since narrative reviews can include questions of sampling, measurement, and stochastic and external validity and generally do not allow quantifying the relationships. In addition, narrative reviews often incorporate several normative and cognitive biases by the researcher (Rosenbusch, Brinckmann, & Bausch, 2011). In turn, by employing a quantitative approach to our systematic literature review, we unveil the scientific roots of U-I research and identify current thematic areas and emerging patterns in the field. In addition, when conducting a qualitative content analysis, we generate different perceptions about relevant future research directions based on the identified articles.

In accordance with the objective of this study, the following research question were formulated:

Q1 - What aspects and categorization of U-I cooperation literature have been studied over the last few years?

This study brings several important contributions. This study presents an SLR on U-I cooperation using bibliometric techniques, analyzing the influencing factors and determinants necessary for U-I cooperation and the results that can be obtained through it. This SLR helps identify what the existing literature has analyzed regarding U-I cooperation and sets the stage for the second wave of research on this topic, summarizing the main deficiencies in knowledge and defining directions for future studies. Second, a conceptual model was proposed that can contribute to future analyzes of the theme. Third, we define a roadmap for an informed research agenda, proposing multiple but clearly defined directions: the use and development of an innovative theory capable of opening new paths for future research and theoretical construction; a more sophisticated understanding of the concept and its applicability; address deficiencies related to the content at different levels of analysis; and also, the implementation of relevant and appropriate methodologies to measure U-I cooperation.

A rigorous research protocol was followed to prepare this SLR (Tranfield, Denyer, & Smart, 2003). The search for articles was carried out in the Web of Science (WoS) database (Gasparyan, Ayvazyan, & Kitas, 2013a). The defined research protocol enabled the inclusion of 109 articles in the investigation, which were subsequently submitted to bibliometric analysis - bibliographic coupling to obtain a similar relationship between the articles grouping them by clusters. The results allowed to identify four distinct

clusters: 1) Triple Helix, 2) Knowledge Transfer, 3) Determinants of Cooperation, and 4) Strategic Alliances.

This review of U-I cooperation will not only enrich the existing literature, but the structure it presents will also contribute to a deeper understanding of the U-I cooperation process. The article also presents a research agenda.

The paper is organized as follows. Section 2 describes the methodology used and the database used in the research study. Section 3 presents the results. Section 4 emphasizes the discussions and future lines of research and finally, section 5 presents the conclusions of the research.

2.2. Methodology

This study was based on an SLR of the literature. It is intended to organize, evaluate and synthesize literature identifying patterns, trends, and gaps in future research (Gough, Oliver, & Thomas, 2012; Tranfield et al., 2003), based on U-I cooperation. According to Tranfield et al. (2003), SLR should be developed based on a rigorous research protocol for minimizing bias.

To achieve the proposed objectives, this study was based on bibliometric analysis. The research conducted used the 1.6.13 version of the VOSviewer software to draw up and present bibliometric maps and identify clusters and their references. It used the bibliographic coupling of documents because it presents advantages over other methods, such as co-citation or direct citation, in terms of precision and the grouping of articles (Boyack & Klavans, 2010). The bibliographic coupling of documents method uses citation analysis to establish a similar relationship between documents. Thus, the more references they cite, the more common the technical background they are based on (Kessler, 1963).

The research was based on collecting articles using the WoS database, and no time restrictions were set. This database was chosen due to its prestige, relevance, and coverage (Gasparyan et al., 2013b), which ensures the quality and diversity of the articles used.

The research was narrowed using the words "cooperation" AND "university-industry" AND "Innovation" as topic. The search conducted found 280 articles. We further limited the search to articles published within the research area of Business Economics and written in English. The application of these filters led to a reduction to 109 articles.

Finally, these 109 articles were submitted to the VOSviewer software, where we started by "creating a map based on bibliographic data", with the articles collected from the WoS database. After, we select "bibliographic coupling" and 10 as the "minimum number of citations of a document" and "5" as "minimum of cluster size". The software application allowed the identification of four clusters, leaving only 51 articles. After obtaining the clusters in VOSviewer, we did an in-depth reading of each of the papers present in the respective clusters. Based on the resulting reading of each cluster, a name was assigned to them. Finally, according to Paul & Criado (2020), our research is classified as a Bibliometric Review. Bibliometric reviews analyze an extensive amount of published research using statistical tools, thus figuring out trends and citations and/or co-citations of a particular theme by year, country, author, journal, method, theory, and research problem. A graphical bibliometric review can be developed using Viewer software programs, such as VoS (Visualization of Similarities), which is widely used to carry out such a bibliometric review in diverse subject areas, including U-I cooperation (Mascarenhas et al., 2018). An issue inherent in many bibliometric analyzes is that out of a given pool of articles, a relatively small number of articles represent a significant part of the total citations in the analysis (Paul & Criado, 2020). The research was conducted on December 16th, 2019.

The research protocol is presented in Figure 2.1.

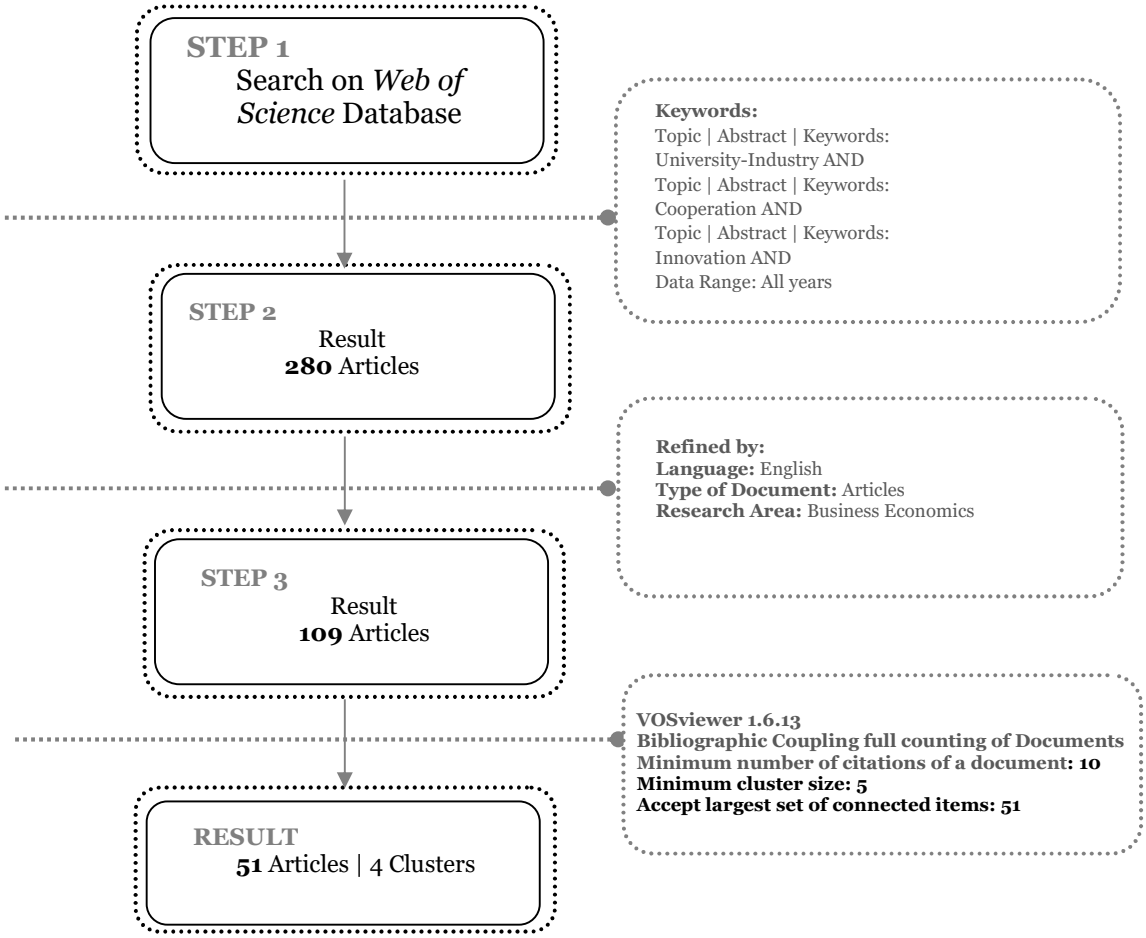


Figure 2.1 - Research protocol

2.3. Results

Figure 2.2 shows the evolution in the number of publications and citations of the 109 articles obtained for analysis from 1995 to 2020. The number of citations has evolved, reaching its maximum in 2019, with 508 citations. The first article on the theme appeared in 1996, and to date, it was in 2019 that it reached its maximum.

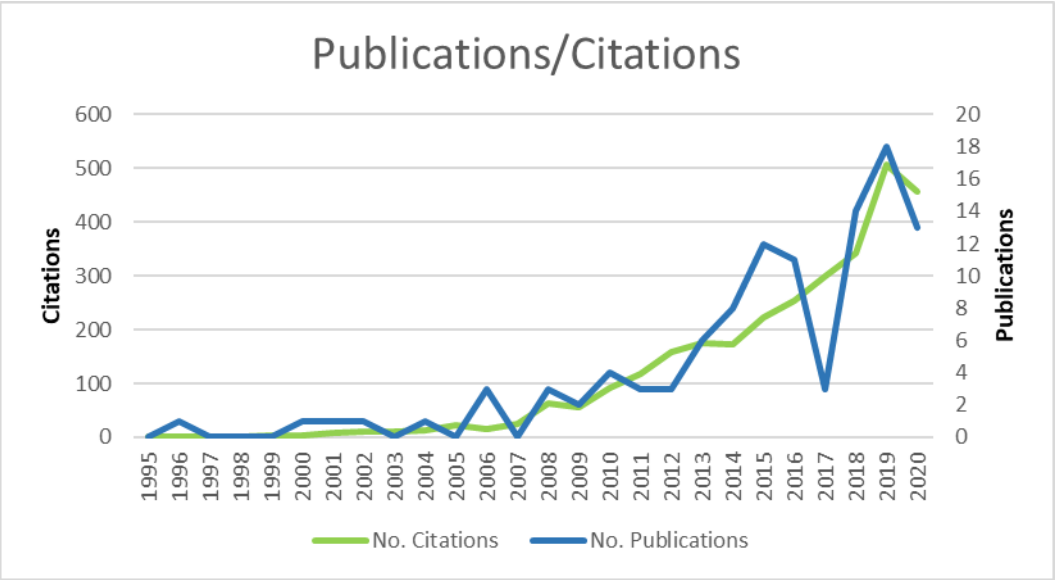


Figure 2.2 - Evolution of the number of publications/citations

Of the 109 articles obtained through this research, 16 (14.68%) have no citations, and 58 (53.21%) have less than 10 citations.

The most cited article focuses on analyzing the determinants that allow cooperation between firms and Public research organizations based on small and medium-sized enterprises (Fontana et al., 2006).

Table 2.1 references the 10 most cited articles.

Table 2.1 - Top 10 of the most cited articles

Article	Authors | Year	Journal	Total Citations	Methodology
Factors affecting university-industry R&D projects: The importance of searching, screening, and signaling	Fontana et al. (2006)	Research Policy	307	Quantitative
Knowledge interactions between universities and industry in Austria: Sectoral patterns and determinants	Schartinger et al. (2002)	Research Policy	306	Quantitative
Technology transfer' and the research university: A search for the boundaries of university-industry collaboration	Lee (1996)	Research Policy	274	Quantitative
Determinants of industry-academy linkages and their impact on firm performance: The case of Korea as a latecomer in knowledge industrialization	Eom and Lee (2010)	Research Policy	117	Quantitative
What drives the formation of 'valuable' university-industry linkages? Insights from the wine industry	Giuliani & Arza (2009)	Research Policy	116	Quantitative
The role of science parks and business incubators in converging countries: Evidence from Portugal	Ratinho & Henriques (2010)	Technovation	108	Quantitative
Longitudinal trends in networks of university-industry-government relations in South Korea: The role of programmatic incentives	Park & Leydesdorff (2010)	Research Policy	106	Mixed
Determinants of university-firm R&D collaboration and its impact on innovation: A perspective from a low-tech industry	Maietta (2015)	Research Policy	103	Quantitative
Knowledge acquisition in university-industry alliances: An empirical investigation from a learning theory perspective	Sherwood and Covin (2008)	Journal of Product Innovation Management	98	Quantitative
Leveraging knowledge, learning, and innovation in forming strategic government-university-industry (GUI) R&D partnerships in the US, Germany, and France	Carayannis et al. (2000)	Technovation	93	Qualitative

To identify trends in the literature related to U-I cooperation, the research on this topic was divided into clusters based on an analysis of bibliographic coupling with articles with at least 10 citations, resulting in 51 articles. Thus, as a result of the analysis of the 109 articles, four clusters were obtained, as can be seen in figure 2.3 - Vosviewer screenshot. The clusters are (1) Triple Helix, (2) Knowledge Transfer, (3) Determining Factors for Cooperation, and (4) Strategic Alliances.

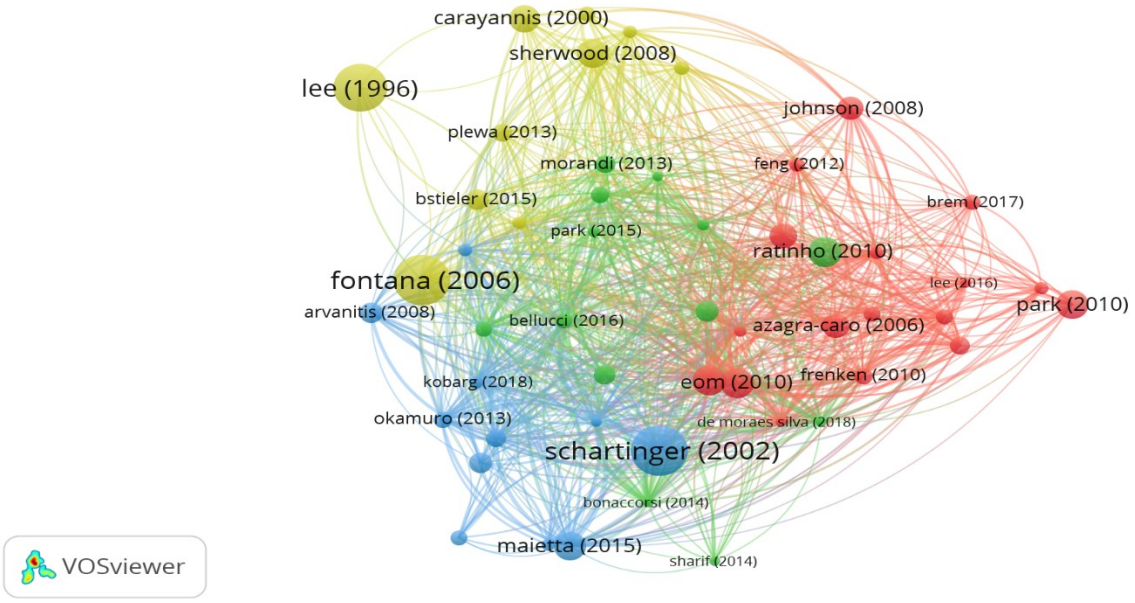


Figure 2.3 - Clusters

Table 2.2 presents the authors that are part of each cluster.

Table 2.2 - Authors of each cluster

Cluster 1 – 17 articles	Cluster 2 – 13 articles	Cluster 3 – 11 articles	Cluster 4 – 10 articles
Azagra-Caro et al. (2006)	Bellucci & Pennacchio (2016)	Arvanitis et al. (2008)	Bstieler et al. (2015)
Brem and Radziwon (2017)	Berbegal-Mirabent et al. (2015)	Ballesteros & Rico (2001)	Carayannis et al. (2000)
Moraes Silva et al. (2018)	Bonaccorsi et al. (2014)	Lehmann & Menter (2018)	Gubbins & Dooley (2014)
Zubielqui et al. (2015)	Franco et al (2014)	Maietta (2015)	Johnson & Johnston (2004)
Eom and Lee (2010)	Muscio & Vallanti (2014)	Nishimura & Okamuro (2011)	Lee (1996)
Farinha et al. (2016)	Ratinho & Henriques (2010)	Okamuro & Nishimura (2013)	Plewa et al. (2013)
Feng et al. (2012)	Vásquez-Urriago et al. (2016)	Scandura (2016)	Santoro & Saparito (2006)
Giuliani & Arza (2009)	Sharif & Tang (2014)	Schartinger et al. (2002)	Sherwood & Covin (2008)
Heitor (2015)	Morandi (2013)	Slavtchev (2013)	Simeth & Raffo (2013)
Johnson (2008)	Park et al. (2015)	Kobarg et al. (2018)	Fontana et al. (2006)
Jones & Zubielqui (2017)	Raesfeld et al. (2012)	Wirsich et al.(2016)	
Park & Leydesdorff (2010)	Raesfeld et al. (2012)		
Robin & Schubert (2013)	López et al. (2015)		
Bellucci et al. (2019)			
Frenken et al. (2010)			
Lee & Kim (2016)			
Ponds (2009)			

Cluster 1: Triple Helix

Table 2.3 presents the articles that are part of cluster 1 where the importance of the government is addressed, namely the TH model, when U-I cooperation through government measures and laws, as well as through cooperation platforms.

Table 2.3 - Articles of cluster 1

Authors	Article	Journal	Contribution
Eom and Lee (2010)	Determinants of industry-academy linkages and their impact on firm performance: The case of Korea as a latecomer in knowledge industrialization	Research Policy	Identification of the determinants for cooperation between industry-university and industry – Government Research Institutes and their impact on company performance. It was possible to verify that government support plays a fundamental role mainly in R&D projects
Giuliani & Arza (2009)	What drives the formation of 'valuable' university-industry linkages? Insights from the wine industry	Research Policy	Exploring the factors that drive the formation of links between university and industry. The importance of knowledge transfer was also analyzed in business growth and development
Park & Leydesdorff (2010)	Longitudinal trends in networks of university-industry-government relations in South Korea: The role of programmatic incentives	Research Policy	Analysis of research relations established between university-industry-government using the triple helix indicator. It was found that government intervention will depend on the economic structure and culture of each country
Robin & Schubert (2013)	Cooperation with public research institutions and success in innovation: Evidence from France and Germany	Research Policy	Evaluation of the impact on companies, cooperation with public research regarding product and process innovations. It was found that innovation and economic development reflect the context in which it occurs
Azagra-Caro et al. (2006)	Faculty support for the objectives of university-industry relations versus degree of R&D cooperation: The importance of regional absorptive capacity	Research Policy	To understand how regions analyze innovation through pressure for cooperation with European universities, it is essential to pay attention to government support, political measures, and the country's culture
Johnson (2008)	Roles, resources, and benefits of intermediate organizations supporting triple helix collaborative R&D: The case of Precarn	Technovation	An intermediary organization can assist Triple Helix partners in successfully commercializing new technologies. Thus, government intervention should be based on the culture, organizational functioning, incentive mechanisms, and objectives of each actor
Farinha et al. (2016)	Networks of Innovation and Competitiveness: A Triple Helix Case Study	Journal of the Knowledge Economy	The processes of transferring knowledge and technology that occur between U-I through an EU-funded R&D project should have government intervention that will have to leverage opportunities for cooperation and eliminate barriers that may exist
Feng et al. (2012)	The role of intellectual capital and university technology transfer offices in university-based technology transfer	Service Industries Journal	Development of a theoretical model to explain relationships between intellectual capital, research results, and knowledge transfer performance Specialized technological offices
Zubielqui et al. (2015)	Knowledge transfer between actors in the innovation system: A study of higher education institutions (HEIS) and SMEs	Journal of Business and Industrial Marketing	Small and medium-sized companies access knowledge through external actors and higher education institutions, increasing access to knowledge and innovation. In this context, government policies play a key role
Heitor (2015)	How university global partnerships may facilitate a new era of international affairs and foster political and economic relations	Technological Forecasting and Social Change	Structured international relationships can act as agents of change if associated with activities other than the role of universities. Thus, the change in the paradigm of universities implies a change in thinking in industry and government
Jones & Zubielqui (2017)	Doing well by doing good: A study of university-industry interactions, innovationess and firm performance in sustainability-oriented Australian SMEs	Technological Forecasting and Social Change	Human resources play a positive role in the innovation capacity of small and medium-sized companies, and the capacity for innovation is in turn related to the performance of companies. Thus, there is a positive effect on U-I interactions on the results of innovation and the performance of small and medium-sized enterprises
Brem & Radziwon (2017)	Efficient Triple Helix collaboration fostering local niche innovation projects – A case from Denmark	Technological Forecasting and Social Change	U-I cooperation is considered an important factor in the growth of regional ecosystems. As such, efficient Triple Hélix collaboration is needed to promote and support niche innovations
Moraes Silva et al. (2018)	University-industry R&D cooperation in Brazil: a sectoral approach	Journal of Technology Transfer	For sectors other than the most cooperation-intensive outliers, the main determinants of university-industry collaboration are size, extramural R&D, and product innovativeness.
Bellucci et al. (2019)	Public R&D subsidies: collaborative versus individual place-based programs for SMEs	Small Business Economics	The allocation of grant programs aimed at SMEs' investments in individual research projects and the other focused on collaborative research projects between SMEs and universities have different effects if we talk about

			small and medium-sized companies.
Frenken et al. (2010)	The citation impact of research collaboration in science-based industries: A spatial-institutional analysis	Papers in Regional Science	Shows the relationship that the impact of regional, national or international collaboration has on science-based industries
Lee & Kim (2016)	Analyzing interaction in R&D networks using the Triple Helix method: Evidence from industrial R&D programs in Korean government	Technological Forecasting and Social Change	Government intervention is seen as an engine in R&D network interactions in national R&D programs in Korea
Ponds (2009)	The limits to internationalization of scientific research collaboration	Journal of Technology Transfer	Even though international collaboration between academic and non-academic organizations occurs frequently, the collaboration between academic and non-academic organizations is less likely to occur than collaboration between academic organizations at the international level.

According to Brem & Radziwon (2017), U-I cooperation can be a key factor in the growth of regional business ecosystems. The sustainability of companies comes from innovation, and this, in turn, comes from U-I cooperation. Since the 1970s, the interaction between U-I has become formal, frequent, and planned, allowing research, development, innovation, and commercialization initiatives (Farinha et al., 2016). The links established between U-I are different, with inevitably more valuable links than others, namely those based on the potential for knowledge diffusion. For Jones & Zubielqui (2017), it is the transfer of human resources (employment of recent graduates, graduates, professional training for employees) that generates benefits that can result in innovation and turn to the growth and productivity of companies. So, the university that generated knowledge must be directly or indirectly disseminated by the industry (Giuliani & Arza, 2009).

The acquisition of knowledge is fundamental for innovation. SMEs rely on universities and other (non-university) institutions for this purpose, for example, through spillovers from long-term R&D and growth improvements in the value chain (Zubielqui et al., 2015). The universities with specialized technology transfer offices promote knowledge transfer performance based on U-I cooperation. Thus, the greater the relational capital, that is to say, cooperation, the more positive the results in research and the performance of knowledge transfer (academic research and patent technology) to the industry (Feng, Chen, Wang & Chiang, 2012). The growing perception of the potential benefits resulting from U-I cooperation has been notorious. So, an international collaboration between academic and non-academic organizations occurs frequently (Ponds, 2009).

Moraes Silva et al. (2018) analyzed the determinants of U-I cooperation by dividing them into two groups of distinct variables, internal and external. They evaluated the company's size, product innovation, and process innovation in terms of internal characteristics. In terms of external characteristics, they evaluated the market and

government policies, such as economic risk, cost of innovation, and government financing.

The U-I cooperation can be difficult to create and sustain for several reasons, including the lack of socio-economic conditions, such as the prevalence of SMEs and the lack of tradition in cooperation with the scientific base (Azagra-Caro, Archontakis, Gutiérrez-Gracia & Fernández-de-Lucio, 2006), culture, organizational functioning, incentive mechanisms, as well as the differentiation of objectives of each of them (Johnson, 2008).

A new relationship paradigm arises between government and industry intervention associated with knowledge - the TH model. According to Heitor (2015), the relationships between U-I-G can act as agents of change if associated with training, social behavior, and economic appropriation of knowledge. In this process, universities play a different role from the traditional one. According to Park & Leydesdorff (2010), differentiation is imposed within each of the vectors of the TH model, i.e., U-I-G. Universities intend to publish scientific articles, the industry wants to make money from cooperation, and the government represents the public power. For these authors, government intervention will depend on each nation's economic structure and research portfolio.

Interactions between TH players can improve countries' R&D capabilities. In this context, government policies must carefully analyze the unwanted effects that they may have. It will then be up to the government, in addition to implementing the policies, to check the existing feedback from universities and industry, encouraging R&D networks (Azagra-Caro et al., 2006; Lee & Kim, 2016). Although the award of government grants is beneficial, the results vary according to the type of cooperation established. Government incentives attributed to companies for the development of research projects have improved the performance of companies. On the other hand, the government incentives attributed to companies cooperating with universities have not resulted in such positive results, leading to concern in expenditure on R&D and employment (Bellucci et al., 2019). According to Frenken et al. (2010), the impact of research collaboration is more significant when international cooperation is involved. However, there are industries, such as biotechnology and organic chemistry, in which collaborations between U-I-G on a regional scale bring more advantages. Factors like physical proximity (Frenken et al., 2010), company size, and intensity in R&D do not determine factors for U-I-G cooperation (Eom & Lee, 2010).

According to Eom & Lee (2010), through participation in national R&D projects, government support is one of the most significant and robust factors both for U-I cooperation and cooperation between industry-government. This analysis reflects the importance of government policies as facilitators of U-I-G cooperation. However, concerning political implications, public-private cooperation should not be encouraged at all costs, as it may not contribute to all forms of innovation (Robin & Schubert, 2013).

Clusters 2: Knowledge Transfer (KT)

Table 2.4 presents the articles part of cluster 2 that address Knowledge Transfer (KT) due to U-I cooperation, identifying some examples and some limitations.

Table 2.4 - Articles of cluster 2

Authors	Article	Journal	Contribution
Ratinho & Henriques (2010)	The role of science parks and business incubators in converging countries: Evidence from Portugal	Technovation	Science Parks and Business Incubators are tools for economic growth, particularly at the regional level
Vásquez-Urriago et al. (2016)	Science and Technology Parks and cooperation for innovation: Empirical evidence from Spain	Research Policy	The results show that the location in a Science and Technology Parks increases the likelihood of cooperation for innovation and the intangible benefits of cooperation with the main innovation partner, mainly due to a more diversified relationship
Berbegal-Mirabent et al. (2015)	University-industry partnerships for the provision of R&D services	Journal of Business Research	Results indicate that successful R&D contracts depend on university and TTO characteristics and the university's location. They have also presented a set of managerial implications for improving the establishment of university-industry partnerships
Bellucci & Pennacchio (2016)	University knowledge and firm innovation: evidence from European countries	Journal of Technology Transfer	That firms oriented toward open search strategies and radical innovations are more likely to draw knowledge from universities. Furthermore, firms belonging to high technology sectors and firms with high absorptive capacity place greater value on the various links with universities
Muscio & Vallanti (2014)	Perceived Obstacles to University–Industry Collaboration: Results from a Qualitative Survey of Italian Academic Departments	Industry and Innovation	Obstacles were identified, i.e., barriers to university-industry interactions that negatively affect the likelihood of getting involved in collaboration with industry, namely inequality of incentives, lack of procedures, conflict of objectives, and nature of research, namely distance between university and industry. The estimated impact of these perceived obstacles on the frequency of collaborations requires further investigation
Franco et al. (2014)	The influence of academic staff's personal and professional characteristics on the decision to cooperate with industry	European Journal of International Management	Identification of factors related to the personal and professional characteristics of the academic body that influence the cooperation decision. Variables such as sex, age, and education influence the faculty's propensity to cooperate with the business sector
Bonaccorsi et al. (2014)	Participation and commitment in third-party research funding: Evidence from Italian Universities	Journal of Technology Transfer	Universities must explicitly recognize the role of dedicated internal organizations and provide training for professionals capable of acting as value-added intermediaries. Policymakers must want to improve relations between universities and external actors, disciplinary differences between departments, as well as regional inequalities in growth levels, must be carefully considered, giving up a unique approach for all
Sharif & Tang (2014)	New trends in innovation strategy at Chinese universities in Hong Kong and Shenzhen	International Journal of Technology Management	Several specific competitive advantages associated with each of the universities in Hong Kong were presented to boost their

			collaboration related to innovation with institutions and companies in other sectors
López et al. (2015)	Are firms interested in collaborating with universities? An open-innovation perspective in countries of the South West European Space	Service Business	Identification of the determinants of companies interested in cooperating with universities differs according to the technological level of the company's sector. In this type of analysis, the importance of the culture of each country must always be taken into account
Morandi (2013)	The management of industry-university joint research projects: How do partners coordinate and control R&D activities?	Journal of Technology Transfer	Project management must be well defined at the outset because its characteristics and relationship affect the management system's configuration. The uncertainty of the task leads to decentralization of coordination and control practices, equivocity offers incentives for the group coordination mode and reduces the need for continuous informal monitoring, and reciprocal interdependence between partners requires the exploration of project plans
Park et al. (2015)	Exploring potential R&D collaboration partners through patent analysis based on bibliographic coupling and latent semantic analysis	Technology Analysis and Strategic Management	Provide a systematic methodology for exploring potential R&D collaboration partners using patent information
Raesfeld et al. (2012)	When is a network a nexus for innovation? A study of public nanotechnology R&D projects in the Netherlands	Industrial Marketing Management	Analysis of the combined effect of the heterogeneity of the R&D partnership portfolio, interdependence, and connectivity, together with the stability of the network on innovation performance
Raesfeld et al. (2012)	Influence of partner diversity on collaborative public R&D project outcomes: A study of application and commercialization of nanotechnologies in the Netherlands	Technovation	Investigation of the impact of technological diversity and the complementarity of the partner value chain on the performance of public nanotechnology R&D projects

The markets and technology are constantly changing, so the traditional practice of relying exclusively on internal R&D can lead companies to face a major challenge (Park et al., 2015). Few studies have been developed that focus on the interaction between U-I, more specifically on the performance of their collaboration. According to Raesfeld et al. (2012), there is a strong positive impact on technological diversity and the complementarity of the value chain of partners in the performance of public R&D projects.

Raesfeld et al. (2012) explained innovation based on two factors, namely the diversity of partners and social incorporation. For these authors, the heterogeneity of resources is a significant factor insofar as participants from different sectors and different roles in the value chain can bring great advantages in creating radical technology innovations. The search for knowledge from external sources has allowed companies to improve their innovation capabilities. Universities' entrepreneurial capacity and scientific quality are key factors when transferring knowledge to companies (Bellucci & Pennacchio, 2016). The universities are under some pressure to cooperate with the industry. However, factors (inequality in incentives, lack of procedures, conflict of objectives, and the nature of the research, namely distance between university and industry) can hinder this cooperation, particularly regarding KT. Companies associated with innovative activities, particularly with product innovation, tend to be more interested in collaborating with universities (López et al., 2015). Continuous and long-

term cooperation can help to reduce conflicts and barriers, thus allowing cooperation that benefits both parties (Muscio & Vallanti, 2014). On the other hand, companies with a strategy with a vision of radical innovation, high technology companies, and companies with high absorption capacity will be more likely to capture the knowledge transmitted by universities (Bellucci & Pennacchio, 2016). The organizational and institutional characteristics, as well as the location of the university, are considered determining factors for successful R&D partnerships (Berbegal-Mirabent et al., 2015; López et al., 2015). For Franco et al. (2014), the personal and professional characteristics of the researchers affect the decision to cooperate. In personal characteristics, variables such as gender, age, and university influence cooperation between U-I, while in professional characteristics, meetings, conferences, and publications are the basis of cooperation. Competitive advantages, opportunities for field experiences, financing of academic activities, and transferring knowledge and technology are some of the benefits of U-I cooperation (Morandi, 2013).

According to Bonaccorsi et al. (2014), universities are associated with a "third mission" that establishes connections with knowledge holders and facilitates technology and knowledge transfer. These authors analyzed cooperation between U-I, combining factors at the individual, departmental, university, and territorial levels. In the first phase, universities must understand the need to offer training to professionals to add value. Another internal aspect is creating a technology transfer office to maintain the connection with the industrial world. On the other hand, the differences between departments and regional differences must also be considered, as departments located in wealthier regions will be more involved in financing and cooperation with third parties.

Knowledge transfer from universities to the industry is considered an important strategy for boosting business and encouraging and developing innovation. Knowledge Transfer Offices will be the main drivers of partnerships established between U-I (Berbegal-Mirabent et al., 2015). The technological knowledge of companies is obtained through research centers and governments for establishing partnerships (Park et al., 2015). For Ratinho & Henriques (2010), Science Parks and Business Incubators influence economic development, as well as job and wealth creation in developed and developing countries. Although the contribution of SPs and BI is modest, cooperation with universities can be considered an asset for the growth of the converging economy, as is the case in Portugal. The creation of Science and Technology Parks was one of the most important innovation policies. The location in these parks has had a positive effect on innovation, cooperation, and the intangible benefits of cooperation, thanks to

a diverse relationship. However, it is difficult to see whether the results obtained through this cooperation will be better (Vásquez-Urriago et al., 2016).

Sharif & Tang (2014) analyzed the U-I cooperation and U-I-G, focusing on knowledge transfer. Universities engage in innovative activities through their departments and researchers, thus boosting their relationship with institutions and companies in other sectors. The lack of a clear pattern of organization among the elements of TH should allow academic researchers to contribute more robustly to the innovation system.

Clusters 3: Determinants of Cooperation

Table 2.5 presents the articles that are part of cluster 3, addressing the organizational characteristics that may be presented as more likely when U-I cooperation.

Table 2.5 - Articles of clusters 3

Authors	Article	Journal	Contribution
Schartinger et al. (2002)	Knowledge interactions between universities and industry in Austria: sectorial patterns and determinants	Research Policy	The intensity of knowledge interactions does not follow a simple sectorial pattern, being influenced by a large set of different factors that produce a complex pattern of interactions
Maietta (2015)	Determinants of university-firm R&D collaboration and its impact on innovation: A perspective from a low-tech industry	Research Policy	Geographical proximity and training programs are the determinants of collaboration between universities and industry in R&D
Arvanitis et al. (2008)	Is there any impact of university-industry knowledge transfer on innovation and productivity? An empirical analysis based on swiss firm data	Review of Industrial Organization	Knowledge Technology Transfer activities with research institutions and/or institutions of higher education seem to improve the innovation performance of firms considerably both in terms of R&D intensity and sales of new products
Nishimura & Okamuro (2011)	R&D productivity and the organization of cluster policy: An empirical evaluation of the Industrial Cluster Project in Japan	Journal of Technology Transfer	Analysis of the effects of the "Industrial Cluster Project" (ICP) on the participants' R&D productivity
Okamuro & Nishimura (2013)	Impact of university intellectual property policy on the performance of university-industry research collaboration	Journal of Technology Transfer	Analysis of the impact of the university's intellectual property policy which is fair in the division of revenues and royalties of innovative results and applied flexibly according to the needs of the partner, contributing to improving the performance of the project, increasing the commitment of the companies
Ballesteros & Rico (2001)	Public financing of cooperative R&D projects in Spain: The Concerted Projects under the National R&D Plan	Research Policy	Factors such as budget and company size influence Spanish public sector decision-making on funding research projects developed in collaboration with U-I
Scandura (2016)	University–industry collaboration and firms' R&D effort	Research Policy	Verification of a positive and significant impact on publicly funded U-I collaboration in the UK companies' R&D effort
Lehmann & Menter (2018)	Public cluster policy and performance	Journal of Technology Transfer	The growth of the regional GDP measures evaluation of the effect of the active public policy of the cluster, but the importance of robust evaluation approaches and techniques are highlighted. On the other hand, it is important to verify the complementary effects of pre-existing entrepreneurial and innovative ecosystems to stimulate regional wealth and make cluster policy

			successful at work
Slavtchev (2013)	Proximity and the Transfer of Academic Knowledge: Evidence from the Spatial Pattern of Industry Collaborations of East German Professors	Regional Studies	Characteristics such as physical proximity and tacit knowledge during U-I interactions allow local development
Wirsich et al. (2016)	Effects of University–Industry Collaboration on Technological Newness of Firms	Journal of Product Innovation Management	U-I cooperation has a significant positive effect on technological innovations, with two years, allowing for the recombination of existing knowledge and the ease in implementing new technologies
Kobarg et al. (2018)	University-industry collaborations and product innovation performance: the moderating effects of absorptive capacity and innovation competencies	Journal of Technology Transfer	Absorption capacity and innovation skills should be considered in the context of innovation performance in U-I cooperation, although these may not have an exclusively positive influence on U-I cooperation

The establishment of external partnerships, especially with universities, is considered an engine of technological development. Thus, companies with an open innovation strategy that intends to collaborate with universities will be able to obtain excellent resources, knowledge, and technological innovations. The interdisciplinary exchange of knowledge is essential for technological development (Wirsich et al., 2016). Schartinger et al. (2002) analyzed the patterns of interaction of knowledge between the academic and business sectors based on different research fields and sectors of activity. For these authors, the intensity of knowledge interactions does not follow a simple sectorial pattern and is not restricted to just a few specific industries or fields, and varies according to several determinants. Apparently, universities and industries use different channels in the interaction of knowledge. For Slavtchev (2013), U-I cooperation consists of a complex correspondence process between partners and factors such as individual, relational characteristics, institutional factors, and the specific type of knowledge that play a central role in establishing this cooperation.

Maietta (2015) analyzed the factors that drive U-I collaboration and how that collaboration affects the innovation process. Factors such as geographical proximity and training programs in areas useful for companies positively affect product innovation. Other approved studies concluded that the size of the company, tacit knowledge (Slavtchev, 2013), general information, educational activities, research activities, activities related to technical infrastructure and consultancy (Arvanitis et al., 2008), R&D capacity, intellectual property policies and the educational level of the managers are determining factors for cooperation between U-I (Okamuro & Nishimura, 2013). However, there are barriers associated with U-I cooperation, such as divergent cultures and objectives, which must be considered (Wirsich et al., 2016). For Okamuro & Nishimura (2013), the company's size does not influence U-I cooperation because the performance of U-I cooperation depends on the strategies established between partners.

Knowledge and technology transfer activities with universities or research institutions improve companies' innovation performance (both in terms of R&D and sales of new products), positively influencing production (Agasisti et al., 2019)(Arvanitis et al., 2008). Absorption capacity and innovation skills should be considered in the context of innovation performance in U-I cooperation, although these may not have an exclusively positive influence on U-I cooperation. Everything will depend on the type of innovation, incremental or radical, that the cooperation wants to achieve (Kobarg et al., 2018).

Several factors can lead the public sector to finance projects developed by the company in collaboration with universities and public research organizations. The budget and the destination of that budget will be the most important factors in explaining this financing. On the other hand, the public sector tends to finance smaller companies more dedicated to R&D than larger companies with large R&D departments (Ballesteros & Rico, 2001). Scandura (2016) investigated the impact of U-I cooperation based on public funding in R&D projects. He concluded that there is a positive impact on companies looking to increase private investment in R&D, creating knowledge in the economy and increasing job opportunities in the labor market.

The theory of economic knowledge suggests that innovation and new knowledge create opportunities for technological changes obtained through cooperation between entrepreneurial companies and research institutions. This cooperation also generates regional development, hence the need to create an active public policy (Lehmann & Menter, 2018; Slavtchev, 2013).

Industrial clusters have played a leading role in innovation, with several countries having developed specific promotion policies for these clusters. The «Industrial Cluster Project» aims, in addition to building collaboration networks between U-I, the development of regional industries. Thus, to improve the R&D efficiency of local companies, it is important to build collaborative networks within and beyond the clusters (Nishimura & Okamuro, 2011).

Clusters 4: Strategics Alliances

Table 2.6 presents the articles that are part of cluster 4, which addresses the type of alliances that can be established between U-I, the characteristics necessary for them to materialize, and the results obtained.

Table 2.6 - Articles of cluster 4

Authors	Article	Journal	Contribution
Lee (1996)	Technology transfer' and the research university: A search for the boundaries of university-industry collaboration	Research Policy	Definition of the role of universities in technology transfer through alliances such as consortia, alliances, collaborative research and development projects, staff exchange, and individual interaction between professors and professionals in the sector
Sherwood & Covin (2008)	Knowledge acquisition in university industry alliances: An empirical investigation from a learning theory perspective	Journal of Product Innovation Management	Factors such as trust, familiarity, formal collaboration teams, and communications from technology experts, which are inherent to the context of knowledge acquisition, can affect the transfer of technology from universities to industry
Carayannis et al. (2000)	Leveraging knowledge, learning, and innovation in forming strategic government-university-industry (UIG) R&D partnerships in the US, Germany, and France	Technovation	If there is an understanding of the nature, process, and contents of the collaboration between government, university, and industry actors, results such as knowledge sharing, social capital, and innovation can be achieved
Plewa et al. (2013)	University-industry linkage evolution: An empirical investigation of relational success factors	R and D Management	The relational success factors necessary for creating alliances are communication, trust, understanding, and individuals
Bstieler et al. (2015)	Trust formation in university-industry collaborations in the U.S. biotechnology industry: IP policies, shared governance, and champions	Journal of Product Innovation Management	The importance of defining the roles of universities' Intellectual Property policies and shared management in building trust between universities and the industry
Johnson & Johnston (2004)	Organisational knowledge creating processes and the performance of university-industry collaborative R&D projects	International Journal of Technology Management	Analysis of the effects of enablers and knowledge creation processes in a collaborative environment
Simeth & Raffo (2013)	What makes companies pursue an Open Science strategy?	Research Policy	Explore which are the motivations of companies that disseminate research results in a scientific format
Santoro & Saparito (2006)	Self-interest assumption and relational trust in university-industry knowledge transfers	IEEE Transactions on Engineering Management	Examine the role of self-interest and relational trust in the transfer of knowledge between U-I
Gubbins & Dooley (2014)	Exploring Social Network Dynamics Driving Knowledge Management for Innovation	Journal of Management Inquiry	Analyze how a social network can influence the knowledge management process for innovation
Fontana et al. (2006)	Factors affecting university-industry R and D projects: The importance of searching, screening, and signalling	Research Policy	One of the determinants of research cooperation between companies and public research organizations is the "absolute size" of the industrial partner. Companies that outsource research and development and patents to protect innovation and signal competencies have higher levels of collaboration

Since knowledge is considered a critical resource to guarantee the growth and survival of companies, they are motivated to cooperate to achieve this transfer of knowledge (Santoro & Saparito, 2006). Companies' technological knowledge (innovations in products and processes) is obtained through internal learning processes and external sources such as universities (Sherwood & Covin, 2008). According to Johnson & Johnston (2004), knowledge conversion processes are more relevant when examined together, instead of separately, and the facilitating factors depend on the organizational context under analysis. It is known that knowledge and skills are key factors for innovation. However, the process is complicated and difficult to manage due to the various actors involved in the network (Gubbins & Dooley, 2014). It is then necessary to understand the nature, process and content that these cooperation's can bring both in the formulation of governmental policies and in the elaboration of corporate strategies (Carayannis et al., 2000).

The more interactions between partners, in this case, U-I, the more and better knowledge sharing, and absorption capacity will be since the actors will better understand the specifics of each context (Gubbins & Dooley, 2014). Other factors can

affect partnerships and the success of knowledge acquisition, such as familiarity, formal collaboration teams, communications with technology specialists (Plewa et al., 2013; Sherwood & Covin, 2008), R&D Capacity, and size of companies (Fontana et al., 2006). The greater the degree of trust between partners, the greater the transfer of knowledge and innovation performance. Thus, U-I will win if they can develop an environment of trust (Bstieler et al., 2015; Santoro & Saparito, 2006).

The U-I cooperation can offer benefits for the parties involved and the economy in general (Plewa et al., 2013). In addition, these partnerships also serve to accelerate organizational learning and coordinate trans-organizational "innovation communities" (Carayannis et al., 2000). Lee (1996) intended to understand what role academics played in technology transfer and industrial innovation and how they could collaborate with private industry. For these authors, universities actively participate in local and regional economic development. To this end, cooperation mechanisms have been developed, such as consortia, alliances, research and collaborative development projects, staff exchange, and individual interaction between teachers and professionals in the sector. However, universities should not engage in close commercial partnerships with private industry, such as investment in stocks.

Several studies focus on universities as part of commercial activities, but few refer to companies as disseminators of scientific knowledge. According to Simeth & Raffo (2013), companies are more likely to adopt academic principles when they need scientific knowledge considered important, namely for driving innovation.

2.4. Discussion

The conceptual model presented in figure 2.4 summarizes and links the four clusters obtained. It addresses the importance of government in the cooperation process, namely through Triple Helix, the strategic alliances that can be established between U-I, the determining factors for cooperation, and the transfer of knowledge that can get from that connection.

From the analysis of figure 2.4, it is possible to see that several determining factors can positively or negatively influence the cooperation process. The strategic alliances established between U-I are fundamental for developing countries and companies because, on the one hand, it allows economic development and, on the other hand, they allow development, creation, and improvements through KT. Thus, the government plays a fundamental role in this cooperation through the so-called TH, namely by measures, policies, and even government support that it can provide so that success

and understanding between the intervening parties are possible and the objectives achieved.

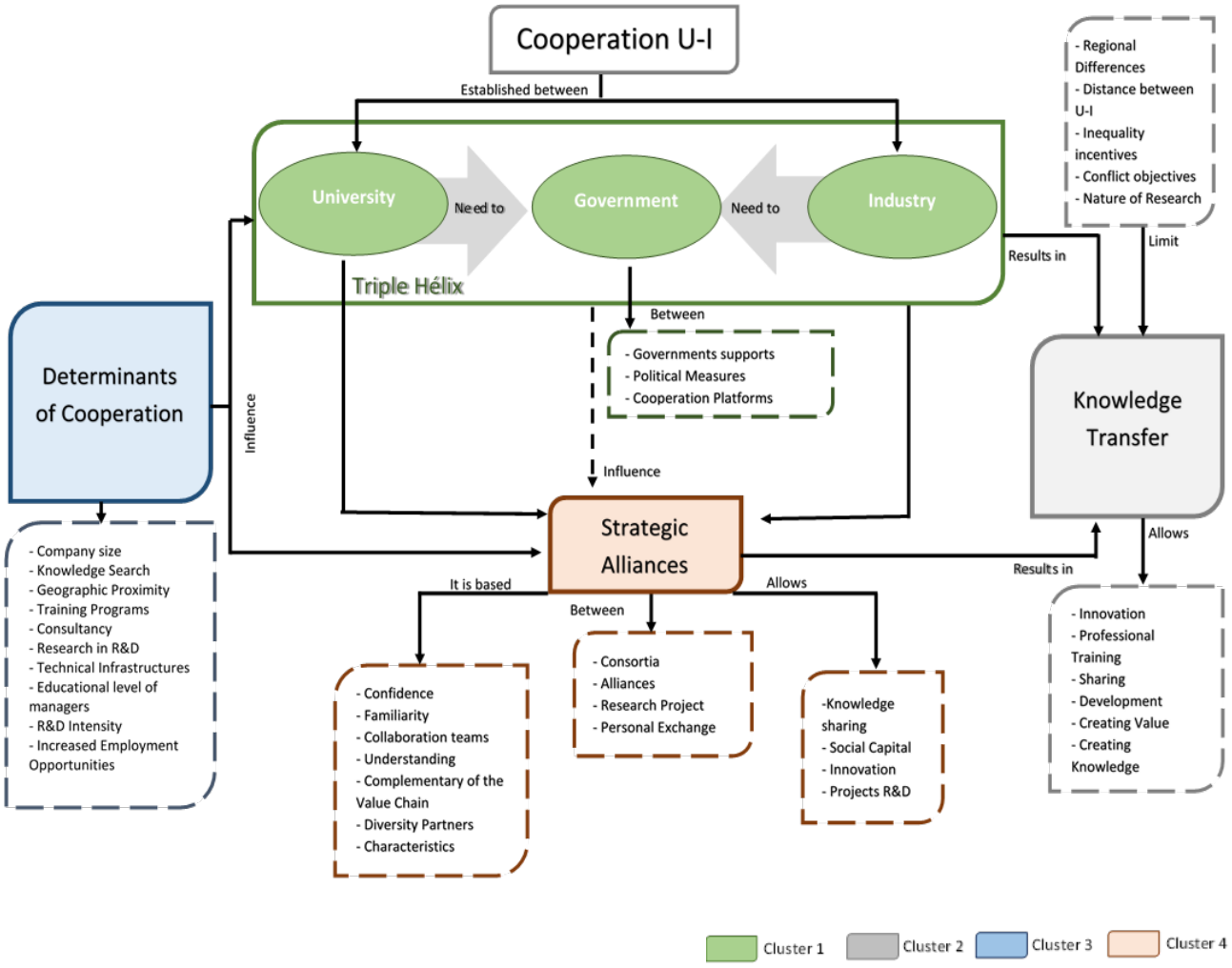


Figure 2.4 - Conceptual

2.5. Conclusion

Given the growing importance of university knowledge and its cooperation with industry, notably due to its influence on economic growth, the government's role is fundamental. However, many barriers may negatively influence this cooperation, especially in less developed countries.

This article was based on an SLR whose theme is the U-I cooperation. Through a bibliometric analysis, it was possible to identify 4 clusters: (1) Triple Helix, (2) Knowledge Transfer, (3) Determinants of Cooperation, and (4) Strategic Alliances.

It was possible to conclude that the U-I cooperation has a crucial role in developing the companies and the economic development of the countries. The benefits of such

cooperation are recognized by all. However, some determinants and barriers must be considered for success and goals to be achieved by all stakeholders. Thus, Triple Helix's government has a fundamental role through its policies, measures, and government support, which may facilitate and even be a mechanism that drives the process. In this sense, a conceptual model was proposed that could contribute to future analysis of the theme. However, by the present SLR, it is possible to perceive the need to further studies on this theme as there is still much to be investigated.

This study contributed to the literature by highlighting the most relevant thematic areas in U-I cooperation, analyzing and systematizing the main investigations carried out in the area, thus allowing a deeper knowledge of the theme and identifying possible future lines of investigation. This SLR also presents contributions to the practice as this theme has generated great interest on the part of governments, policy makers, researchers, industry, and the university, more specifically, to allow the evaluation of other determining factors for cooperation, to identify other types of partnerships, as well as the achievement of results that may result from this cooperation.

From the analyzed literature and based on the first cluster, it was possible to perceive that the intervention of governments, through their political measures, incentive programs, government support and as a factor that streamlines the cooperation process, may be fundamental in U-I cooperation. However, universities and industries have different objectives. Thus, if academics want publications, companies wish for financial gain. As such, the integration in the TH model may allow a dynamic advantage for the parties involved. Thus, for future research, it would be interesting to see if the selective process of creating links between U-I generates improvement in the dissemination of knowledge, both regionally and nationally (Giuliani & Arza, 2009). On the other hand, future research may involve analysis based on various sectors of activity and longitudinal studies to analyze the dynamic nature of the created connections (Zubielqui et al., 2015; Jones & Zubielqui, 2017). Finally, future research should be carried out to study the cooperation between U-I-G from an entrepreneurial perspective.

The second line of research addresses KT from universities to industry and its importance as a vital strategy for boosting business and encouraging and developing innovation. Thus, universities' competitive advantage will depend on their ability to create knowledge. It would be important in future studies to examine the effects of regulatory structures on R&D contracts that are established with the industry (Berbegal-Mirabent et al., 2015). On the other hand, and since the U-I cooperation has

not yet reached its maximum, it would be interesting to develop studies that allow the formulation of hypotheses that involve more research on promoting technological innovation among U-I. Factors such as personal and professional characteristics affect and influence the cooperation process between U-I and the KT. Thus, future research should pay attention to the elaboration of studies that allow the analyzis of the effect of the knowledge transfer and the moderating effect of the absorption capacity in the innovative activities of the companies.

The third line of research made it possible to identify some determining factors in U-I cooperation. Thus, the following aspects were mentioned: the sector of activity (Schartinger et al., 2002), the size of the company (Fontana et al., 2006), the geographical proximity (Maietta, 2015; Slavtchev, 2013), the training programs (Maietta, 2015), educational, research activities, related to technical infrastructures and consultancy (Arvanitis et al., 2008), intensity in R&D, educational level of managers and intellectual property policies (Okamuro & Nishimura, 2013). According to Maietta (2015), the company's size does not influence the process of cooperation, innovation, and development. However, in future research, it would be interesting to analyze whether the process of cooperation, innovation, and development advances in micro-companies as in medium and large companies. Although previous studies have shown the importance of cooperation in various sectors of activity, it would be important to understand how it has evolved. Thus, it would be interesting for future research to carry out studies with longitudinal data (Arvanitis et al., 2008). Another result perceived by the literature review is that cooperation between U-I depends on the strategies established between partners, namely about intellectual property. In future research, it would be interesting to analyze the impact on U-I cooperation in a more dynamic way, considering the evolution of the university's intellectual property policies (Okamuro & Nishimura, 2013). The U-I cooperation develops the countries' economic activity, with the role of the government being central to the cooperation to develop effectively. Thus, future research should focus on the identification of the factors considered determinants in U-I cooperation, at national and international level.

In the fourth and final line of research, it was possible to see that there are many advantages to U-I cooperation, both for companies and the economic development of countries. Thus, it is necessary to develop mechanisms that allow the effectiveness of the established strategic alliances since technological knowledge and the development of innovations are not obtained only through internal learning processes. It would be interesting in future research, namely through the analysis of case studies, to understand the role of inter-organizational management mechanisms in U-I

collaborations (Bstieler et al., 2015). On the other hand, future research must be carried out to identify the various factors that classify partners and competitors (Park et al., 2015).

Although this article brings important collaborations to the literature on U-I cooperation, namely through the systematization of research areas and, due to these, articulating possible lines of future research, it is not free of some limitations. One of the study's limitations is that it resorted to using a single database for the collection of literature (WoS). On the other hand, the criterion for grouping articles into clusters (Bibliographic Coupling) may have limited the scope of the study. Despite the limitations underlying, we believe that this study produces important implications for the cooperation U-I field of research. The analysis of data through the co-citation and the recourse to a quantitative approach result in the mapping of the scientific publications and their intellectual structure and defines the trends ongoing in U-I cooperation theoretical research.

Last but not least, we think it is important to reflect on the Covid-19 pandemic and U-I cooperation. As the OECD (2020) reflected, the pandemic brought several challenges to the educational system. However, we can take as positive the increase in U-I cooperation in several innovative projects. Portugal appears in front of the countries analyzed by the Organization for Economic Cooperation and Development (OECD)[1] as the largest number of innovative projects fighting against Covid-19. The entity highlights 19 initiatives, placing Portugal ahead of Ireland and the United Kingdom. According to OECD (2020), as we enter the COVID-19 recovery phase, it will be critical to reflect on the role of educational systems – and particularly vocational education – in fostering resilient societies. The global health crisis and the lockdown that followed have brought professions that have often been taken for granted, renewing our awareness of their value to society. This has helped restore a sense of esteem for those workers who have worked relentlessly during this time to keep economies afloat. The outlook is very uncertain. But, if anything, the pandemic has exposed our vulnerability to crises and revealed how precarious and interdependent the economies we have built could be. Disruptions on the scale we have just witnessed are not limited to pandemics but may also result from natural, political, economic, and environmental disorders. Our capacity to react effectively and efficiently in the future will hinge on governments' foresight, readiness, and preparedness. Through their role in developing the competencies and skills needed for tomorrow's society, education systems will need to

[1] https://oecd-opsi.org/covid-response/

be at the heart of this planning. This means collaborating with other government and private sectors to increase certain professions' attractiveness and labor-market prospects, including those considered paramount for the common good. Real change often takes place in deep crises, and this moment holds the possibility that we won't return to the status quo when things return to "normal". While this crisis has deeply disruptive implications, including for education, it does not have predetermined outcomes. The nature of our collective and systemic responses to these disruptions will determine how we are affected by them. In this sense, the pandemic is also a call to renew the commitment to the Sustainable Development Goals. Ensuring that all young people have the opportunity to succeed at school and develop the knowledge, skills, attitudes, and values that will allow them to contribute to society is at the heart of the global agenda and education's promise to our future society. The current crisis has tested our ability to deal with large-scale disruptions. It is now up to us to build a more resilient society as its legacy.

Chapter 3. Triple Helix Model– Cooperation in Knowledge Creation

Abstract

The cooperation between universities and industry is decisive. It influences the development of innovation, knowledge transference, and the development of countries. On the other hand, the government plays a crucial role in developing policies to finance and leverage these relationships to increase innovation and competitiveness.

This study aims to analyze the influence of local and regional, national, and European government support has on companies' cooperation with other firms, universities, or governments. This article uses the database of the 2014 Community Innovation Survey. The method uses logistic regression. This research contributed to realizing that public funds play a fundamental role in developing cooperation between Triple Helix (TH) agents; however, not all have the same level of influence. The results confirm that when companies obtain public funds to innovate, there is a significant impact on TH intervening agents' cooperation. The central government and the European Union funds are the most significant in that cooperation process.

Keywords: University-Industry Cooperation, Triple Helix, CIS, Public funding

3.1. Introduction

Innovation has been a crucial element for companies (Badillo et al., 2017) and is a tool to gain a competitive advantage (Robert M. Grant, 2013; Vlasova, 2021). Thus, innovation plays an essential role in firms' economic performance (Ferreira, Fernandes, & Ferreira, 2020) and its development (González-Pernía, Parrilli, & Peña-Legazkue, 2015). Most companies lack the means and knowledge to innovate. In this sense, they use R&D strategies to establish partnerships with other agents (Cabon-Dhersin & Gibert, 2020; Meoli, Paleari, & Vismara, 2013) to be more competitive. Besides, they set up collaboration R&D agreements to obtain new tools and knowledge (Un & Rodríguez, 2018) and exchange resources and ideas (Kang, Li, Cheng, & Kraus, 2021). Thus, companies have a faster and easier way to access innovation (Husted & Michailova, 2010).

Diverse partners can cooperate, namely customers, suppliers, competitors, group firms, universities, and research institutes. Various partners' existence is advantageous because it allows the acquisition of complementary knowledge or capabilities (Badillo & Moreno, 2016; Fernandes & Ferreira, 2021; Iammarino, Piva, Vivarelli & Von Tunzelmann, 2012; Sánchez-Sellero & Bataineh, 2021). Cooperation between University-Industry (U-I) is a source of growth because it encourages knowledge transfer, drives innovation, and improves companies' performance (Aiello et al., 2019; Link & Müller, 2020; Scott, Hughes, & Kraus, 2019). However, despite the increasing cooperation between U-I, and to overcome possible barriers, governments must encourage such collaboration (Badillo et al., 2017).

The Triple Helix (TH) Model is an indicator that examines the relationships of cooperation that are established between university-industry-government (U-I-G) (Park & Leydesdorff, 2010) to achieve innovation (Etzkowitz & Leydesdorff, 2000). U-I cooperation has advantages for the intervening parties, although often with different objectives. In TH model, each vector seeks differentiation (Johnson, 2008). In this process, universities intend to obtain patents (Eom & Lee, 2010), publish scientific articles, and get funding. On the other hand, the industry wants to make money from that cooperation, and the government represents the public power (Park & Leydesdorff, 2010). Despite this, the current pandemic has raised important questions about the role of governments and universities. The governments must care for citizens and non-citizens and their relationship with universities. On the other hand, greater U-I cooperation is necessary, given universities' role in society, health management obligations, and economic crises (Blackmore, 2020).

Since regional policies are essential in constructing technological infrastructures, government intervention in developing the TH will depend on each nation's economic structure and research portfolio (López, Astray, Pazos, & Calvo, 2015). Thus, government policies have a fundamental role in promoting the collaboration between U-I, namely through public funds, in encouraging research, enabling private development (Aiello et al., 2019; Badillo et al., 2017; Busom & Fernández-Ribas, 2008; Vlasova, 2021), and to encourage regional technological progress (Chen et al., 2016; Johnson, 2008).

Earlier studies analyzed the influence of the use of public funds on the cooperation process set up by companies (see: Alarcón & Arias, 2018; Badillo & Moreno, 2016; Busom & Fernández-Ribas, 2008; Hernández-Trasobares & Murillo-Luna, 2020; Junior & Odei, 2018; Prokop, Odei, & Stejskal, 2018). However, those researches have several limitations, namely, the use of only one sector of activity (Alarcón & Arias, 2018), the utilization of a database of a specific country (Badillo & Moreno, 2016; Hernández-Trasobares & Murillo-Luna, 2020; Prokop et al., 2018), or the analyzes of a limited geographic area (Junior & Odei, 2018). On

the other hand, it is also essential to consider the research's relevance based on cooperation between firms (Stejskal et al., 2016) and universities (Bozeman, Fay, & Slade, 2013).

According to Suh, Woo, Koh, & Jeon (2019), it is necessary to develop more studies about U-I cooperation and the effects of government funds in R&D. The present study aims to understand the government's role in creating knowledge and innovation inside the existing relationships between U-I-G. This work seeks to respond to the need for more research contributing to closing a GAP of the literature. So, the following research question was formulated:

Q1 - What is the role of government (public funds) in creating knowledge?

Thus, it analyzes the influence of public funds – local/ regional, central, or European Union (EU) - in establishing partnerships of companies with the agents of TH from the same country or another EU country.

This research offers a valuable contribution to measuring public funds' influences on the development of TH agents' cooperation. Another contribution is showing academics, politicians, and business leaders that public funds play a fundamental role in developing cooperation between TH agents when referring to the most used.

The paper is structured as follows. The following section will approach the literature about the TH and the cooperation between companies and their agents. The third section describes the method and the database used, and the fourth section presents the results and the discussions. Section five offers the implications for academics and practitioners. The article ends with the study's conclusions, limitations, and directions for future research.

3.2. Theoretical underpinnings and hypotheses

Accordingly to Etzkowitz & Leydesdorff (1995), TH model explains innovation due to a collaborative process that involves three complementary agents: universities, industries, and governments. This research, and according to the existing literature about TH, will analyze the cooperation established by companies with each element of TH. Thus, Helix 1 will refer to the cooperation between companies, Helix 2 to the U-I cooperation, and Helix 3 to the cooperation established with the government.

3.2.1. Cooperation Theory and Triple Helix Model

The cooperation theory (CT) supplies a robust theoretical basis for explaining the cooperation between TH agents. According to CT, knowledge sharing occurs between

organizations belonging to TH, when they exchange experiences and have the motivation, trust, and cooperation to achieve common goals (Eom & Lee, 2010). Cooperation is the relationship that is proved between individuals, groups, and organizations through the division of capacities and complementary resources or leveraging them to obtain a mutual benefit objective (Osarenkhoe, 2010). However, to achieve that common goal, it is essential to cooperate between all team elements, and there should be no competition, namely for resources or prestige. Constructive and cooperative behaviors within a group allow for an increase in the quality and the acceptance of the solutions developed by them (Tjosvold, 1984).

The current era of the global economy has led to increasing importance and the need for innovation and knowledge transfer (Carayannis, Campbell, & Grigoroudis, 2021; Stejskal et al., 2016), including between TH agents. Companies must innovate to survive in increasingly competitive markets (Cefis & Marsili, 2006). Thus, the need to promote cooperation between companies and other partners leads to creating working groups that impact its growth (Stejskal et al., 2016), allowing for an increase in social welfare (Cabon-Dhersin & Gibert, 2020). The selection of partners for cooperation, such as customers, suppliers, competitors, group companies, universities, and research institutes can be advantageous as it allows the acquisition of complementary knowledge or skills (Badillo et al., 2017; Iammarino, Piva, Vivarelli, & Tunzelmann, 2012; Veugelers & Cassiman, 2005), bringing success to companies focused on R&D (Seo, Chung, & Yoon, 2017).

Many studies demonstrate the importance of establishing partnerships to obtain certain benefits (see: Badillo et al., 2017; Iammarino et al., 2012; Lhuillery & Pfister, 2009; Miozzo & Dewick, 2004; Silva & Leitão, 2009; Stejskal et al., 2016; Veugelers & Cassiman, 2005). Thus, a new relationship paradigm emerges between government and industry intervention in association with knowledge – the TH model. According to Heitor (2015), the relationships between the U-I-G can act as agents of change if associated with training, social behavior, and the economic appropriation of knowledge. Thus, universities have started to play a different role from the traditional one. For companies, TH explains the positive effect of cooperation between various agents, allowing the acquisition of knowledge (Badillo et al., 2017; Badillo & Moreno, 2016), in addition to developing research, development, innovation initiatives, and their commercialization. The U-I-G cooperation also allows identifying possible opportunities and restrictions in the process (Farinha et al., 2016; Leydesdorff & Park, 2014). According to Johnson (2008), TH is fundamental for regional technological development. However, it can be challenging to create and sustain for several reasons: culture, organizational functioning, incentive mechanisms, and differentiation of objectives. Thus, according to the TH's perspective, the various agents involved in cooperation for business

innovation can provide additional knowledge, resources, and skills (Badillo et al., 2017) and improve the R&D capacities of countries (Johnson, 2008).

3.2.2. Hypotheses and Conceptual Model

3.2.2.1. Financing and cooperation between companies (Helix 1)

In the current era of globalization and the knowledge economy, companies must achieve innovation and knowledge to broaden their horizons and grow economically (Bravo, Serralheiro, & Militar, 2016). Cooperation between companies is beneficial, as it allows them to acquire valuable knowledge, and thus being able to take advantage of positive synergies (Badillo et al., 2017; Badillo & Moreno, 2016). Firms do not always have the essential resources for developing their activity (Un & Rodríguez, 2018). The intention is that each partner contributes with unique resources and functional capabilities that the other lacks (Wu, Shih, & Chan, 2009). Thus, the cooperation's success will depend on the partner's choice (Franco & Pinho, 2019). On the other hand, different companies will have diverse goals and interests. It will be essential to identify common goals to form successful collaborative relationships (Chin, Chan, & Lam, 2008).

The relationships between companies result from a complex and dynamic interaction influenced by the characteristics of the institutional environment, the organizational logic, and the attitudes and experiences of interested parties (Ricciardi, Zardini, Czakon, Rossignoli, & Kraus, 2021). The strength of inter-organizational cooperation can be responsible for the industry's improved performance. It is possible to use knowledge and technologies from various organizations, namely subcontractors or suppliers, government, universities, architects or engineers, customers, and international collaborations (Miozzo & Dewick, 2004). For Iammarino, Piva, Vivarelli, & Tunzelmann (2012), companies' technological capabilities, such as introducing new products or processes, are associated with cooperation between companies, namely customers, suppliers, and universities. The cooperation between firms for R&D activities can take various forms: vertical cooperation with customers or suppliers, institutional cooperation with companies in the same group; and horizontal cooperation with competitors in the same sector (Badillo et al., 2017). Collaboration with competitors, this is horizontal cooperation, is also known as co-opetition. This concept involves competition and cooperation, as it refers to a partnership between companies, which are also competitors (Mention, 2011). For Park, Srivastava, & Gnyawali (2014), co-opetition brings several benefits that allow both partners' development, namely through the acquisition of new resources and the improvement of internal innovation obtained by sharing the partner's knowledge.

Thus, it is essential to distinguish the R&D partner in cooperation because the government's type of financing may have a different impact. The questions about the efficiency and effectiveness of public funding in R&D have been of increasing interest to governments, as it is essential to evaluate public support (Teirlinck & Spithoven, 2012).

There is evidence that local/regional government funds influence companies' cooperation (Junior & Odei, 2018). According to Odei, Prokop, & Stejskal (2020), the government must implement policies that encourage the allocation of subsidies from the central government and the EU because they positively influence the development of new products and innovation process. The following research hypothesis are proposed:

H1a: The type of funds (local/regional, central government, or EU) obtained by companies positively influences the cooperation with other companies of the same country (Helix 1);

H1b: The type of funds (local/regional, central government, or EU) obtained by companies positively influences companies' cooperation from another European country (Helix 1).

3.2.2.2. Funding and cooperation with universities (Helix 2)

In a modern society increasingly based on knowledge (Etzkowitz & Leydesdorff, 2000), and by cooperating with industry, universities begin to focus on their "third mission" (Etzkowitz & Leydesdorff, 2000). Universities have the function of teaching and research, but they should also have the mission to help companies and countries' economic development (Etzkowitz & Leydesdorff, 2000). Universities impact socially, artistically, and scientifically the countries(Link & Müller, 2020). These have a significant and fundamental role in society, namely in the establishment of partnerships established with the industry, in the development of knowledge, innovation (Lopes & Lussuamo, 2020; Mowery & Sampat, 2004; Säär & Rull, 2015; Stejskal et al., 2016), and ideas (Fontana et al., 2006). Universities are essential partners, leading those with which they cooperated to present a more positive overall performance (Scott et al., 2019; Stejskal et al., 2016) and to the development and the economic progress of the industrialized nations (Chen et al., 2016; N. L. Figueiredo & Ferreira, 2021). Companies associated with innovative activities, particularly product innovation, tend to be more interested in collaborating with universities (Fernández López, Pérez Astray, Rodeiro Pazos, & Calvo, 2015; Puffal, Ruffoni, & Spricigo, 2021; Silva & Leitão, 2009). When this occurs, companies can have access to technologies (Cassiman & Veugelers, 2002; Miozzo & Dewick, 2004; Säär & Rull, 2015), to the markets (Cassiman & Veugelers, 2002; Säär & Rull, 2015), and to highly qualified researchers, and specialists (Dooley & Kirk,

2007). They also benefit from economies of scale in R&D and /or production, sharing risks related to the R&D processes (Fischer & Varga, 2002).

For Feng, Chen, Wang, & Chiang (2012), universities promote knowledge transfer performance based on U-I cooperation. Thus, the greater the relational capital, that is, cooperation, the more positive the associated results.

Since the perception of the potential benefits resulting from cooperation between U-I has been well known (Chen et al., 2016), it will be necessary to adopt public policies that can support this cooperation (Stejskal et al., 2016). Collaboration with universities increases the likelihood of new products on the market (Monjon & Waelbroeck, 2003) and the obtention of public funds (Vlasova, 2021).

According to Puffal et al. (2021), there is a positive influence between U-I cooperation and obtaining public funds mediated by the results obtained in innovation. So, getting local, central, or EU funding increases the likelihood that companies will engage in joint research or contract research projects with universities (Goel et al., 2017). According to Odei et al. (2020), there is a positive correlation between local, regional and, EU financing and U-I cooperation, namely developing new products and developing the innovation process. Teirlinck & Spithoven (2012) state that regional governments' financing effect is more favorable in cooperation with universities and more limited with public research centers. Prokop & Stejskal (2018) claim that collaboration with universities that central government funds support becomes insignificant in companies' performance. Still, cooperation based on EU funds already significantly influences companies' performance and growth. Rõigas, Mohnen, & Varblane (2018) disagree, stating that the central government's funding increases the likelihood of cooperation with universities, primarily national.

So, the present study formulates the following hypotheses based on the existing research:

H2a: The type of funds (local/regional, central government, or EU) obtained by companies positively influences the cooperation with universities of the same country (Helix 2);

H2b: The type of funds (local/regional, central government, or EU) obtained by companies positively influences universities' cooperation from another European country (Helix 2).

3.2.2.3. Financing and cooperation with the government (Helix 3)

The acquisition of knowledge is fundamental for innovation, and for that, companies trust universities and other (non-university) institutions. According to Azagra-Caro, Archontakis, Gutiérrez-Gracia, & Fernández-de-Lucio (2006), to achieve regional development, particularly concerning innovation, there must exist cooperation between U-I. However, this will only be possible by developing policies and resources that improve innovation paths through the relationship between companies and universities, and non-universities organizations (Zubielqui, Jones, Seet, & Lindsay, 2015). Thus, if U-I cooperation is desirable, political measures should be supported, considering their regional context. Since the 1970s, U-I interaction has become formal, frequent, and planned (Farinha et al., 2016). The countries' governments develop numerous initiatives that allow U-I cooperation, recognizing the importance of industrial innovation and serving as a local stimulus for development (Mowery & Sampat, 2004).

However, not all studies are unanimous in considering a positive relationship between obtaining EU funds and the industry's development. In this line, Teirlinck & Spithoven (2012) believed that EU programs' funding had not affected cooperation between industry and science, neither with universities nor with public research centers.

Odei et al. (2020) stated that policies that encourage business innovations, such as financing and subsidies from central and European governments, need to be promoted because they positively influence product and process innovation performance. The relationship between U-I-G is changing (Etzkowitz & Leydesdorff, 2000), with a departure from the traditional model of unidirectional collaboration between university and industry and the increasing importance of the government (Carayannis & Campbell, 2009). In this context, government policies must carefully analyze the unwanted effects that they may have. It will then be up to the government to implement the policies, check the existing feedback from universities and industry, and encourage R&D networks (Lee & Kim, 2016). For Jensen & Trägårdh (2004), economic growth can be an easy plan in vulnerable regions through U-I-G collaborations, but they are challenging to manage and implement.

Although the governments have been considered sceptical, it plays a crucial role in U-I cooperation, notably through the financing of R&D projects (David, Hall, & Toole, 2000), providing legal and financial support (David et al., 2000; Polt, Rammer, Gassler, Schibany, & Schartinger, 2001), the development of promotion programs (Polt et al., 2001), or through the implementation of a policy of sharing ideas (such as ownership intellectual property), among the various innovation actors (Seo et al., 2017). Through supporting programs,

government intervention may reduce risk perception and, at the same time, increase the cooperation of companies with universities (Seppo, Rõigas, & Varblane, 2014).

It is important for governments that U-I cooperation grows and promotes innovation because it is the only way the country has to increase its competitiveness (Alarcón & Arias, 2018). Thus, public financial resource allocation will substantially impact business innovation through R&D cooperation agreements (Alarcón & Arias, 2018; Badillo et al., 2017). Currently, EU funding programs for R&D have increased the scope of funds for developing transnational industrial research and giving business support for universities and companies and local and regional authorities. As public funds have a more significant potential to guarantee effectiveness due to the capacity for control and reliability, it is essential to assess how they influence companies to cooperate with regional agents (Junior & Odei, 2018).

Thus, the following hypotheses are proposed:

H3a: The type of funds (local/regional, central government, or EU) obtained by companies positively influences the cooperation with the government of the same country (Helix 3);

H3b: The type of funds (local/regional, central government, or EU) obtained by companies positively influences the cooperation with the government from another European country (Helix 3).

3.2.2.4. Conceptual Model

The study aims to identify the influence of public funds on the cooperation process with TH agents of the same country or other EU country. This paper analyzes the agents involved in TH, that is, between companies, universities, and the government. Concerning the analysis of the data made available in the CIS, it was possible to identify three groups with which the companies established some cooperation, namely other companies, where a) other enterprises within the same enterprise group; b) suppliers of equipment, materials, components or software, c) customers or clients from the private sector, d) clients or customers from the public sector, e) competitors or other enterprises in the same sector; f) consultants or commercial labs; in the field of cooperation with universities, or other higher education institutes; and in the area of cooperation with the government, including public or private research institutes.

The conceptual framework, exposed in figure 3.1, postulates that obtaining public funds is positively related to companies' cooperation with the TH agents.

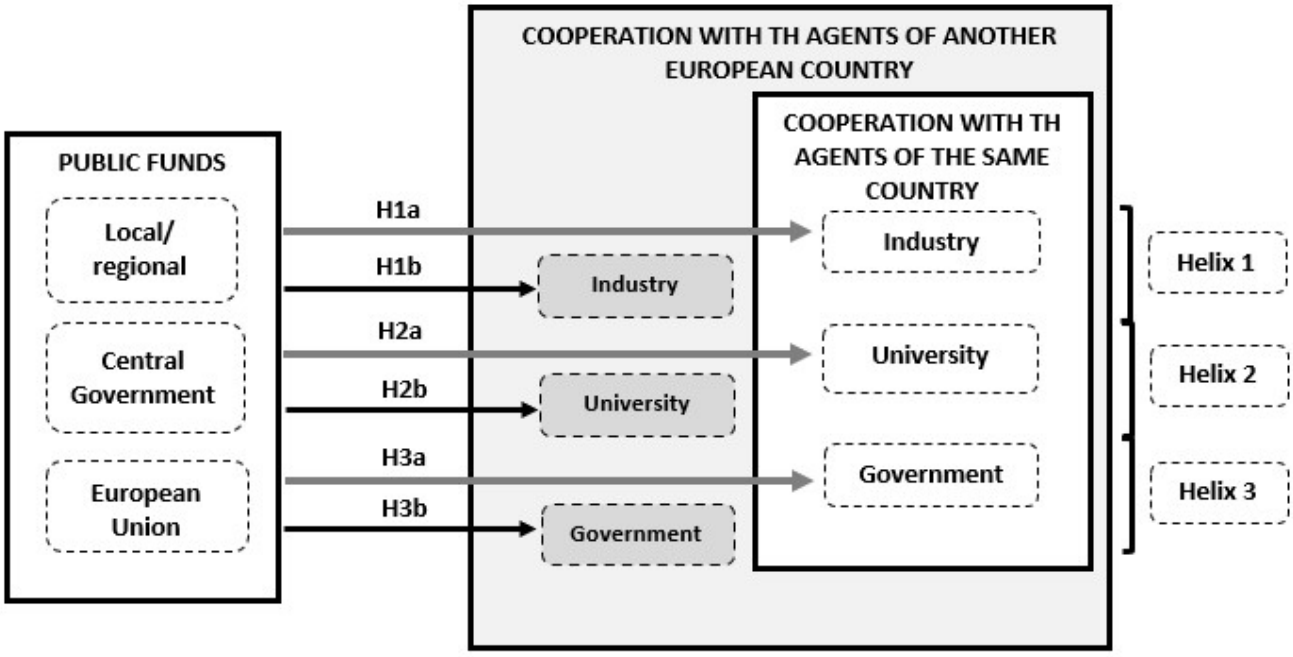


Figure 3.1 - Model of the influence of public funds in cooperation between TH's agents

3.3. Methodology

3.3.1. Data

The empirical analysis of this research uses secondary data from the Community Innovation Survey (CIS). The data included in the present study are from CIS 2016, beginning in 2012 until the end of 2014. They have 97463 observations. The CIS presents a harmonized questionnaire from EU member states and includes EU science and technology statistics, being the primary statistical survey on innovation in companies. This database holds several types of information about the companies' cooperation, namely the partner and the public funding used. The questionnaire was implemented under EUROSTAT – European Statistical System's supervision, based on the conceptual framework provided in the Oslo Manual (OECD, 2005). Several authors resorted to the CIS database for their research and analysis over the years (Goel et al., 2017; Laursen & Salter, 2006; Madeira, Carvalho, Moreira, Duarte, & Filho, 2017; Moura et al., 2020; Prokop et al., 2018; Seppo et al., 2014).

The questionnaire was implemented in 14 European countries, under the supervision of EUROSTAT. The responses of companies belonging to the database in the period mentioned were analyzed, namely Germany (6282), Bulgaria (14255), Croatia (3265), Spain (30333), Estonia (1760), Greece (2507), Hungary (6817), Latvia (1501), Lithuania (2421), Norway (5045), Portugal (7083), Republic Czech (5198), Romania (8206) and Slovakia (2790), in a total of 97463 companies.

3.3.2. Variables

Several dichotomous variables were considered to assess the theoretical hypotheses formulated above. The dependent variable refers to the various modes of cooperation that companies can establish with TH agents. The CIS shows the multiple partners with which companies can cooperate, either with agents from the same country or other European agents.

Regarding cooperation with other companies, two new variables were created: cooperation with companies in the same country and cooperation with other companies from another EU country. The new variables added the following items: other enterprises within your enterprise group; suppliers of equipment, materials, components, or software; clients or customers from the private sector; clients or customers from the public sector; competitors or other enterprises in the same sector; consultants or commercial labs. The variable of cooperation with universities includes universities or other higher education institutions, and in the field of cooperation with the government, the variable contemplated government and public or private research institutes.

According to the literature review carried out and based on the TH principles, three types of cooperation must be considered: a) with other companies (Helix 1), with other companies/agents; b) universities (Helix 2) when companies cooperate with universities or higher education institutions (HEIs); c) government (Helix 3), when companies cooperate with government agencies or other public institutions. At this point, CIS includes cooperation with public and private research centers and technological centers, as it is common for governments, universities, and private companies to participate in technical centers (Hernández-Trasobares & Murillo-Luna, 2020).

The explanatory variables used in the study are also dichotomous. They are based on the type of financing to which companies can access a) local/regional funds (FUNLOC), b) central government funds (FUNGMT), and c) EU funds (FUNEU).

The rationale behind including a series of control variables is to avoid endogeneity and omitted variable bias problems. The control variables that influence U-I cooperation and the obtention of funds - size, belonging to a group, and economic activities - were introduced in the analysis. A binary variable, 0 represents the company's size if the company has up to 249 employees and 1 if the company has more than 249 employees. Another control variable used is related to belonging or not to a group. Finally, 21 variable control dummies were included based on the two-digit NACE 2 rankings, albeit their coefficients are omitted from our tables.

Table 3.1 presents a summary of the variables included.

Table 3.1 - Summary of variables used in the study

Name of variable	Variables Code	Description of Variable	Hypotheses
Dependents Variables			
Cooperation with firms of the same country - Helix 1	CO_EYC (Co11 a Co51)	1 = if the firm has cooperated with other firms in your country 0 = if the firm has not cooperated with other firms in your country	H1a
Cooperation with universities of the same country - Helix 2	Co61	1 = if the firm has cooperated with universities or other higher education institutions in your country 0 = if the firm has not cooperated with universities or other higher education institutions in your country	H2a
Cooperation with the government of the same country - Helix 3	Co71	1 = if the firm has cooperated with the government or public or private research center of your country 0 = if the firm has not cooperated with the government or public or private research center of your country	H3a
Cooperation with firms from another EU country - Helix 1	CO_EOE (Co12 to Co52)	1 = if the firm has cooperated with other companies in another EU country 0 = if the company has not cooperated with other companies in another EU country	H1b
Cooperation with universities from another EU country - Helix 2	Co62	1 = if the firm has cooperated with universities or other higher education institutions in the other EU country 0 = if the firm has not cooperated with universities or other higher education institutions in another EU country	H2b
Cooperation with the government of another EU country - Helix 3	Co72	1 = if the firm has cooperated with the government or public or private research centre of another EU country 0 = if the company has not cooperated with the government or public or private research centre of another EU country	H3b
Explanatory Variables			
Local/ regional funding	FUNLOC	1 = if the firm had access to local or regional support 0 = if the firm did not have access to local or regional support	
Central government funding	FUNGMT	1 = if the firm had access to support from the central administration 0 = if the firm did not have access to support from the central administration	
European Union funding	FUNEU	1 = if the firm had access to European support 0 = if the firm did not have access to European support	
Control Variables			
Size	SIZE	1 = if the company has up to 249 employees 0 = if the number of employees of the firm is more than 249	
Economic Activities (21 categories; i=1 to 21)	NACEi	1 = if the firm is from the economic activities i 0 = if the firm is not from the economic activities i	
Part of an enterprise group	GP	1 = if the firm was part of an enterprise group 0 = if the firm was not part of an enterprise group	

Table 3.2 shows the frequencies of the types of cooperation established between TH agents and the fact that this cooperation is with agents from the same country or with agents from another EU country. The cooperation that most occurred was with other companies of the same country, with about 9748 (10%) observations. The same conclusion can be drawn of cooperation with other TH agents from another EU country, where the cooperation with other companies being the most common, with 5192 (5.3%) observations. The central government fund was the most obtained, with 8146 (8.4%) observations.

Table 3.2 - Frequencies of the variables

	Frequency	Percentage
Cooperation with firms of the same country	9748	10
Cooperation with universities of the same country	4798	4.9
Cooperation with the government of the same country	4031	4.1
Cooperation with firms of other EU country	5192	5.3
Cooperation with universities of other EU country	1087	1.1
Cooperation with the government of other EU country	899	0.9
Local or regional funding	3815	3.9
Central government funding	8146	8.4
European Union funding	4430	4.5

3.3.3. Econometric Methods

As Hair, Black, Babin, & Anderson (2014), described, multiple regression analysis is a dependence technique whose objective is to use the independent variables to predict the dependent variable. Given the dependent variable's binary character (assuming a value equal to 1, if the company cooperated with any of TH's agents, or a value equal to 0 if the company did not cooperate with any of the agents), the logistic regression model was used. Binary data is quite common among the several categorical data types, and their analysis is based on regression models. The use of this model makes even more sense since the independent variables are also dichotomous (assuming a value equal to 1, if the company had access to any financing, or a value equal to 0 if the company did not access to any funding). The database used contains a very high number of observations and comprises data from 14 countries. The assumption that observations are independent for the logistic regression model could be compromised since observations are collected based on countries, which may cause a clustering effect. To control for some bias in the model due to observations selected by country, it was necessary to adjust the cluster (country) effect in the estimation of standard errors of parameter estimates. For this purpose, the cluster-robust standard errors method of estimating the standard errors of the parameter estimates was used. On the other hand, control variables were also used related to companies such as size, sector of activity, and the fact of belonging or not to a business group. The following model was contemplated to evaluate the established hypotheses, where getting a specific fund/support affects the type of cooperation based by firms with TH agents:

$$P(Y_i = 1) = \frac{1}{1+e^{-f(x)}}, \qquad (1)$$

Where,

$$f(x) = \beta_0 + \beta_1 \text{FUNLOC} + \beta_2 \text{FUNMGT} + \beta_3 \text{FUNEU} + \beta_4 \text{SIZE} + \beta_5 \text{GP} + \sum_{i=1}^{21} \beta_{6i} NACE_i + \varepsilon$$

In the logistic regression equation (1), P's value means the probability of cooperation occurs; that is, the value of Yi is 1. Cooperation refers to the dependent variables, in this case, cooperation with the agents of TH - firms, universities, or government - of the country itself, or with agents of TH of another country of Europe, and can present the following variables: Y_1 - cooperation with companies of the country itself; Y_2 - cooperation with universities of the same country; Y_3 - cooperation with the government of the same country; Y_4 - cooperation with companies of other country of EU country; Y_5 - cooperation with universities of other EU country; Y_6 - cooperation with the government of other EU country. The explanatory variables refer to the type of funds obtained during the cooperation: FUNLOC is local/regional funds; FUNMGT is central government funds, and FUNEU is EU funds. The control variables are SIZE (number of employees), GP (belonging to a group), and NACE (economic activities).

3.4. Results and Discussions

The current study investigates the influence of public funds - local/regional, central, or EU - in establishing partnerships of companies with the agents of TH - companies, universities, and government - of the same country or from another EU country. Even though the importance and the number of scientific research publications existent on TH topic, there have been current calls for additional research on this theme (Suh, Woo, Koh, & Jeon, 2019). This study attempts to understand better the relationship between companies, universities, and governments based on the TH model. After implementing the logistic regression model for the 97463 available observations, the results are in tables 3.3 and 3.4.

Table 3.3 - Logistic regression - Influence of the type of financing on cooperation with TH agents of the same country

	Cooperation with Companies				Cooperation with University				Cooperation with Government			
	B	S.E.	Wald	Exp (B)	B	S.E.	Wald	Exp (B)	B	S.E.	Wald	Exp (B)
Explanatory Variables												
FUNLOC	1.257*	0.187	6.72	3.515	0.807*	0.139	5.83	2.242	1.504*	0.228	6.60	4.501
FUNMGT	1.843*	0.109	16.93	6.320	2.342*	0.152	15.43	10.404	2.239*	0.218	10.26	9.391
FUNEU	1.170*	0.179	6.51	3.221	1.306*	0.224	5.82	3.693	1.095*	0.209	5.23	2.988
Control Variables												
Size	0.557**	0.188	2.97	1.746	0.819*	0.209	3.92	2.269	0.466***	0.322	0.202	1.593
GP	0.955*	0.115	8.33	2.599	0.672*	0.165	4.07	1.956	0.705*	0.258	0.127	2.024
NACE	Included				Included				Included			
Constant	-3.422*	0.155	-22.07	0.033	-3.930*	0.189	-20.82	0.019	-3.936*	0.163	-24.10	0.019
Likelihood Test-Ratio	13554.50*				11233.94*				10180.09*			
Log-Likelihood	-24909.522				-13508.779				-11696.791			
Number of cases	97463				97463				97463			

*$p < 0.001$; **$p < 0.01$; ***$p < 0.05$

Table 3.4 - Logistic regression - Influence of the type of financing on cooperation with TH agents of other EU country

	Cooperation with Companies				Cooperation with University				Cooperation with Government			
	B	S.E.	Wald	Exp (B)	B	S.E.	Wald	Exp (B)	B	S.E.	Wald	Exp (B)
Explanatory Variables												
FUNLOC	0.437**	0.165	2.65	1.548	0.512**	0.150	3.40	1.669	0.828*	0.162	5.10	2.288
FUNMGT	1.344*	0.166	8.12	3.835	1.694*	0.203	8.32	5.439	1.591*	0.129	12.24	4.907
FUNEU	1.560*	0.171	9.09	4.755	2.529*	0.308	8.20	12.553	2.459*	0.201	12.25	11.692
Control Variables												
Size	0.868*	0.218	11.30	2.381	0.899*	0.234	3.84	2.458	0.783*	0.169	4.63	2.186
GP	1.478*	0.131	3.98	4.384	0.629*	0.123	5.10	1.877	0.644**	0.199	3.23	1.904
NACE	Included				Included				Included			
Constant	-4.689*	0.146	-32.08	0.009	-6.473*	0.083	-77.69	0.002	-6.495	0.130	-49.89	0.002
Likelihood Test-Ratio	9482.62*				4284.31*				3622.57*			
Log-Likelihood	-15534.383				-3822.17				-3293.945			
Number of cases	97463				97463				97463			

*$p < 0.001$; **$p < 0.01$

Regarding tables 3.3 and 3.4 and analyzing the results of the Likelihood Test-Ratio ($p <$ .001), at least one of the explanatory variables, public funds in the six regression models, contribute to explain the process of cooperation established with TH agents from the same country or another EU country. So, the hypothesis is rejected that all coefficients are null. Analyzing the Log-likelihood statistic results confirms the general significance of the models compared to the null model. On the other hand, Wald's statistics show that all the explanatory variables are significant to explain the odd of existing cooperation with the TH agents from the same country or another EU country. All values obtained in each scenario are significant ($p <$ .001).

As shown in Table 3.3, all public funds have a positive and significant effect on the cooperation process between companies in the same country, namely, the local/regional funds (β=1.257; p <.001), the central government funds (β=1.843; p <.001) and the EU funds (β=1.170; p <.001). On the other hand, in table 4, it is possible to verify public funds' influence when cooperating with companies from another EU country. The results suggest that all public funds have a positive and significant effect in cooperation between companies - local/regional funds (β=0.437; p <.01), central government funds (β=1.344; p <.001), and EU funds (β=1.560; p <.001). Thus, the odds of cooperation with companies in the same country is 6.320 times greater when companies obtain funds from the central government, compared to those that did not receive it, keeping the other variables constant. On the other hand, the odds of cooperation with companies of other countries in EU is 4.755 greater when companies obtain EU funds, compared to those that did not get it, keeping the other variables constant. Also, the odds are more significant when the funds obtained are those of the central government. Thus, the results support the hypotheses H1a and H1b, that holds that public funds influence the cooperation between companies in their own country and other EU country.

The results of tables 3.3 and 3.4, about cooperation with universities in the same country or from another EU country, allowed us to confirm H2a and H2b. The results show that there are positive and significant effects from all public funds, local/regional funds (β=0.807; p <.001), central government funds (β=2.342; p <.001), and EU funds (β=1.306; p <.001). There is also the same significant effect when cooperation occurs with universities from another EU country (Table 4) - local/regional funds (β=0.512; p <.01), central government funds (β=1.694; p <.001), and EU funds (β=2.529; p <.001). Thus, the odds of cooperation with universities of the same country is 10.404 times greater when companies obtain funds from the central government, compared to those that did not receive it, keeping the other variables constant. On the other hand, the

odds of cooperation with universities of other EU countries are 12.553 greater when companies obtain EU funds, compared to those that did not get it, keeping the other variables constant. Thus, the hypotheses H2a and H2b are confirmed.

Tables 3.3 and 3.4 exposed the results to answer hypotheses H3a and H3b. Regarding the influence of public funds when companies cooperate with the government of the same country, the results indicate that all public funds have a positive and significant effect - local/regional funds (β=1.504; p <.001), central government funds (β=2.239; p <.001), and EU funds (β=1.095; p <.001). When companies cooperate with another government from another EU country (Table 4), the results prove that all public funds have a positive and significant effect on the process of cooperation - local funds/regional (β=0.828; p <.001), central government funds (β=1.591; p <.001), and EU funds (β=2.459; p <.001). Thus, the odds of cooperation with the same country's government is 9.391 times greater when companies obtain funds from the central government, compared to those that did not get it, keeping the other variables constant. On the other hand, the odds of cooperation with other EU countries' governments are 11.692 greater when companies obtain EU funds, compared to those that did not receive it, keeping the other variables constant. Thus, the hypotheses H3a and H3b are confirmed.

The current study investigates the influence of public funds - local/regional, central, or EU - in establishing partnerships of companies with the agents of TH - companies, universities, and government - of the same country or from another EU country. Even though the importance and the number of scientific research publications existent on TH topic, there have been current calls for additional research on this theme (Suh, Woo, Koh, & Jeon, 2019). This study attempts to understand better the relationship between companies, universities, and governments based on the TH model.

TH cooperation could be an essential framework for developing companies, universities (Park & Leydesdorff, 2010; Stejskal et al., 2016), and countries (Alarcón & Arias, 2018; Chen et al., 2016). Public funds and public policies have a significant impact on the development of that cooperation (Stejskal et al., 2016). The significance between the cooperation results obtained with and without their existence is notorious. In this sense, this research confirms the results obtained by Junior & Odei (2018), Prokop & Stejskal (2018), and Odei et al. (2020).

The knowledge of universities has aroused the industry's interest, primarily through the establishment of partnerships. This knowledge has generated interest because it allows the economic growth of companies and governments. Thus, the government's role is

fundamental, whether through policymaking or allocation of funds. The effectiveness of public funds in U-I cooperation for innovation depends on the benefits that companies obtain from the implemented measures (Vlasova, 2021).

3.5. Implications

3.5.1. Theoretical Implications

This article supplies a substantial number of theoretical contributions to TH literature. First, the study confirms that knowledge sharing between organizations improves the results obtained by all partners in the situation that they have joint projects and goals. Public funds are the leverage framework that potentiates those relationships and the effects. Otherwise, no competition between the three agents, namely for resources or prestige, contributes decisively to the increase and the quality of the achieved results. In this sense, 36 years later, this study confirms the results of Tjosvold (1984), in the development of a project, organizations must cooperate rather than compete. The TH model can also allow the existence of the knowledge transfer between TH agents. The presence of cooperation between the TH agents allows this transmission to the advantage of all parties, namely the survival of companies in the increasingly global competitive markets and economic growth. Thus, this study also confirms the results of Cefis & Marsili (2006) and by Stejskal et al. (2016).

This research confirms that TH is a crucial framework for companies to innovate. It favors the development of relations with various partners, leading to its growth, the acquisition of complementary knowledge or skills, and success. At the same time, they increase the focus on R&D. In this sense, this study confirms the results of Seo et al. (2017) and the relevance and timeliness of the CT between organizations. There is an association between government, industry, and universities. Knowledge is the link element in those relations. The change occurs when they establish partnerships with common goals and potentiate the market opportunities.

Hence, in line with some studies carried out on the topic (see: Junior & Odei, 2018; Odei et al., 2020; Prokop et al., 2018; Rõigas et al., 2018), the results strongly support the significant role played by public government funds in the establishments of cooperation, confirming all research hypotheses.

Results indicate that all public funds positively and significantly influence the cooperation established between companies in the same country or another EU country. However, the results also show that of the various types of public funds, the

central government fund is the one that most influences cooperation between companies in the same country, and the EU fund influences cooperation with companies of another EU country. This confirms the results of Junior & Odei (2018) and Odei et al. (2020).

This research also demonstrates that all public funds positively and significantly influence the cooperation between companies and HEIs in the same country or another EU country. However, the results show that of the various types of public funds, the central government fund is the one that most influences cooperation with HEIs in the same country, and the EU fund influences cooperation with HEIs of another EU country. In consequence, those results confirm the works of Goel et al. (2017) and Odei et al. (2020) that public funds positively affect U-I cooperation. Also, it is necessary to promote U-I cooperation to achieve regional development and innovation (de Zubielqui et al., 2015; Mowery & Sampat, 2004). The government plays a fundamental role in implementing measures and policies for that purpose (Farinha et al., 2016). For governments, this cooperation is vital because it improves countries' competitiveness (Alarcón & Arias, 2018). They must optimize the allocation of those public financial resources, which confirms the results of Odei et al. (2020). However, Teirlinck & Spithoven (2012) claim that the public fund did not affect U-I cooperation. This probably occurs because it uses data from the OECD bi-annual business R&D survey 2004 and 2006 for Belgium, a remote period, and considering only one EU country.

All public funds have a positive and significant influence on the cooperation established between companies and the government of the same country or another EU country. However, the results also show that of the various types of public funds, the central government fund is the one that most influences cooperation with the government of the same country, and the EU fund influences cooperation with the government of another EU country.

Finally, this work also responds to a call in the literature for additional research on U-I cooperation and the effects of government funding on R&D (Suh, Woo, Koh, & Jeon, 2019). It illustrates that public funding is essential for establishing cooperation, allowing for the development of companies and countries regardless of their nature.

3.5.2. Managerial Implications

This study confirmed the importance of obtaining public funds for establishing cooperation, whether it be companies, universities, or the government. It would be necessary for companies to become aware of increasing their cooperation network to

achieve innovation. Thus, companies must adopt policies and strategies that promote cooperation and collaboration for innovation, eventually taking advantage of the available public resources. They must increase cooperation with universities and research centers and develop long-term partnerships as far as possible. Universities have a mission to develop research and improve knowledge and innovation. In this line, companies have significant benefits in cooperating with them (Mowery & Sampat, 2004; Säär & Rull, 2015; Stejskal et al., 2016).

Thus, the organization leaders must be aware of the funds available from the government. Instead, leaders should see these funds as an opportunity to increase their knowledge and improve their performance. To develop U-I cooperation, HEIs could take initiatives in this direction. On the other hand, HEIs must develop proactive measures that allow the development of society and the economy, disseminate knowledge, and use their third mission. The current pandemic further reinforces the need for HEIs to interact and cooperate with companies.

Of all the public funding considered for this research, central government funding is the most significant source of cooperation with all TH agents when cooperation is with agents of the same country. When cooperation is with TH agents from another EU country, the EU's is the most relevant public fund. Cooperation is a fundamental factor for companies and countries, allowing for innovation and development. Thus, the importance of cooperation with HEIs has increased, as has the role of the government. All TH agents recognize the benefits of cooperation. Therefore, the government must develop and promote its public funds. Central and even local governments must facilitate cooperation between companies and or HEIs, to enable growth in R&D and innovation. Thus, differentiated initiatives should be developed and offered according to each country and company's specific needs and strategies.

3.6. Conclusions, limitations, and future research directions

This article aimed to analyze the influence of public funds in cooperation between companies and TH agents. According to the objective of this research, the logistic regression model was used to test the hypotheses. The results strongly support the role played by central government financing in cooperation. Thus, it is possible to conclude that all public funds have a positive and statistically significant influence on the cooperation established by companies with TH agents from the same country or another EU country, supporting all established research hypotheses. Although the

study confirms the importance of all types of public funds, the central government fund is the one that most influences the cooperation of companies with any of the agents of TH when they are in the same country. In turn, EU funds affect the cooperation established with companies, HEIs, and governments of another EU country.

Regardless of its nature, public funding is essential for establishing cooperation that allows companies and countries' development. However, central government and EU funds are the most widely used to establish cooperation with all the TH agents of the same country or another European country, respectively. If cooperation is a crucial factor for developing companies and countries, allowing the creation of innovations, the pandemic we are experiencing today reinforces this fact. This pandemic has generated a global economic and social crisis, making learning and development crucial for companies and businesses, reinforcing the importance of cooperation with universities and the government's role.

Although this paper provides essential contributions to the literature and practice, the same is not without limitations. An important aspect is that the survey included only the countries that participated in the CIS data. On the other hand, the data used refers to the year 2014. The lack of access to some variables is another limitation of the CIS questionnaire. The study has an aggregated analysis of the data. Future studies may consider the breakdown of each country because different countries have different policies as well. Thus, it is essential to develop specific approaches to consider each context to promote TH agents´ cooperation. Future research would be essential to analyze the importance of public funds in different activity sectors. A suggested analysis could be a division between technological and non-technological sectors.

Chapter 4. Determining Factors For U-I Cooperation: a European Study

Abstract

Companies need to innovate to remain in the market and be competitive. Thus, success will depend on your internal resources and the external sources of knowledge used. The cooperation between industry and universities (U-I) allows companies to access resources that, in general, they do not have, allowing them to achieve innovation, competitive advantages, and competitiveness.

This study analyzes the determinants considered essential for companies to establish cooperation processes with universities. The research uses the last Community Innovation Survey dataset, data from 14 countries, and 28743 observations. The method uses logistic regression. The results confirm that the company's size, the innovative capacities associated with R&D, exportation, and public funds are essential and significant determinants for the cooperation with universities. On the other hand, the acquisition of machinery and training programs are not a critical factor in establishing cooperation with universities that are not in the same country. The analysis considered companies' cooperation with universities of the same country, from the European Union (EU) or other countries outside the EU. In addition to providing substantial theoretical contributions on the subject, this research also provides more information about the importance of U-I cooperation, allowing to characterize companies interested in developing U-I cooperation.

Keywords: U-I Cooperation, Innovation, Community Innovation Survey, U-I Cooperation Determinants.

"*The research on university-industry linkages has steadily increased during the last few decades, recognising universities and other research institutions as the important actors for economic growth and international competitiveness*." (Rõigas et al., 2018, pp.35).

4.1. Introduction

Companies need to innovate to grow, survive and resist the competition felt in the current market (Fernández-López et al., 2019). Innovation is related to their ability to absorb information, knowledge, and external technologies by establishing partnerships with other entities such as competitors, suppliers, customers, universities, and public organizations (Badillo et al., 2017). Through their culture, internal and external resources, and capabilities, companies achieve and create innovation (Ayala & González-Campo, 2015).

A country's prosperity increases with its ability to access new knowledge and innovations. Thus, governments are interested in understanding the origin, development, and integration of new knowledge in the innovation process. In this order, universities play an increasingly significant role in countries' economic growth by creating innovation, knowledge, and technology transfer (Capron & Cincera, 2003).

Companies have shown a growing interest in establishing cooperation with universities since they are an essential technical knowledge source (Bozeman, Fay, & Slade, 2013). Thus, governments should focus their public policies on U-I cooperation, promoting it (Segarra-Blasco & Arauzo-Carod, 2008).

The cooperation link between U-I permits companies to obtain information and knowledge. The universities' entrepreneurial and scientific capacities are fundamental in transferring knowledge to the industries (Bellucci & Pennacchio, 2016). At the same time, they complement companies' innovation activities (Medda, 2020). Cooperation between companies and universities is a source of economic growth because it encourages knowledge transfer, increasing innovation and companies' performance (Jones & Corral de Zubielqui, 2017; Rõigas et al., 2018). Additionally, technological innovations are increasingly recognized to achieve collective results (Fiaz, Yang, & Abbas, 2014).

In recent years, universities have played a fundamental role in companies' economic development (Miller, McAdam, & McAdam, 2018). However, the interaction between the agents involved when transferring knowledge does not follow a simple pattern. This

process is not restricted to just a few specific industries or fields and varies according to several determinants (Rõigas et al., 2018). Universities and industries use different channels to interact with knowledge (Schartinger et al., 2002).

The lack of knowledge about the main determinants that allow University-Industry (U-I) collaboration is one of the barriers that hinder innovation relations between agents (López, Astray, Pazos, & Calvo, 2015). The analysis of U-I cooperation determinants is beneficial and crucial because it reduces the complexity of cooperation and facilitates the innovation process (Rõigas et al., 2018). There were several factors identified as being decisive in U-I cooperation, namely: the sector of activity (Schartinger et al., 2002; Segarra-Blasco & Arauzo-Carod, 2008), the company's size (Fontana et al., 2006), geographical proximity (Maietta, 2015; Slavtchev, 2013), training programs (Maietta, 2015), educational and research activities related to technical infrastructures and consultancy (Arvanitis, Sydow, & Woerter, 2008), the intensity in Research & Development (R&D), the educational level of managers and intellectual property policies (Okamuro & Nishimura, 2013).

Earlier studies analyzed the determinants that influence U-I cooperation (õigas et al., 2018; Segarra-Blasco & Arauzo-Carod, 2008). However, the previous studies have several limitations, namely, the analysis of a single country or a small group of countries (Aiello et al., 2019; Schartinger et al., 2002; Segarra-Blasco & Arauzo-Carod, 2008) or the analysis of U-I cooperation only in a specific sector of activity (Silva, Simoes, Sousa, Moreira, & Mainardes, 2014). U-I cooperation is a complex phenomenon, and not all companies are concerned and can cooperate. The lack of knowledge and understanding about the determinants that originate this cooperation is one of the reasons that hinder the correct scientific and technological transfer (Fernández López et al., 2015). Despite this issue's relevance, Aiello et al. (2019) suggest developing new studies in this research area. On the other hand, Segarra-Blasco & Arauzo-Carod (2008) also suggest developing new research based on a comparative analysis between the determinants that influence the cooperation established with national and foreign universities. Thus, there is a gap in the literature that allows for a comparative analysis of the determinants that would U-I cooperation with national and foreign universities. So, the following research question was formulated:

Q1 - What factors influence U-I cooperation?

The present study aims to understand the determinants that influence U-I cooperation in creating knowledge and innovation. Thus, it analyzes the companies' size, innovation

activities, exportation, and government funds on the propensity to collaborate with national and foreign universities. The empirical analysis of the determinants that drive cooperation used secondary data from the Community Innovation Survey (CIS) for 2012-2014 with 28743 observations. The sample consists of companies that had, at that time, at least one innovative activity.

In this sense, this study contributes to closing an essential GAP in the literature. This article offers a valuable contribution to the literature using many countries and compares the U-I cooperation determinants. On the other hand, it focuses on differences between firms cooperating with domestic and those cooperating with foreign universities.

The paper is structured as follows. The following section will approach the literature about U-I cooperation determinants. The third section describes the method and the database used, and the fourth section presents the results. Finally, section five offers the discussions and implications for academics and practitioners. The article ends with the study's conclusions, limitations, and directions for future research.

4.2. Theoretical underpinnings and hypotheses

4.2.1. Theory of Resources and Capacities

The resources and capacities of a company will be the basis for producing goods and services that allow it to generate a sustainable competitive advantage (Ayala & González-Campo, 2015). However, firms have limited benefits and do not always have the necessary resources to develop their activity (Un & Rodríguez, 2018). Technological innovation and competition play an increasing role in developing markets and technologies, making cooperation agreements between U-I an option increasingly considered by companies (Franco & Haase, 2015). The choice of universities like partners for cooperation can be advantageous because it allows the acquisition of knowledge and skills (Badillo et al., 2017). According to Tether (2002), universities are essential cooperation partners to companies when the latter have: - a considerable economic or financial risk to innovate; - rigidity or organizational inadequacy; - difficulties with regulations or industry standards; - a lack of information about technologies or markets where they act.

Companies' innovation needs a strategy that combines resources endogenous to the organization with others obtained through cooperation with complementary agents (Fontana et al., 2006). in this line, the opening of companies to the search for external

knowledge significantly contributes to the development of R&D projects (Fontana et al., 2006). That knowledge allows companies to get new skills and routines, complimentary access to resources, and market information (Walsh, Lee, & Nagaoka, 2016). In this way, and according to the theory's premises based on resources and capacities, value creation combines complementary inimitable resources (Wiklund & Shepherd, 2009).

According to Grant (1991), the Theory of Resources and Capacities (TRC) definition requires a clear distinction between companies' resources and competencies. Resources are inputs to the production process. Thus, resources include all assets controlled by a company, allowing it to implement initiatives that improve its efficiency and effectiveness. In turn, capabilities reflect how companies capture resources' potential value to gain a competitive advantage (Grant, 1991). To a correct relationship between resources and capabilities, the companies must cooperate (Grant, 1991).

The theory of resources and capacities is fundamental to explaining U-I cooperation because organizations have access to vital resources for their subsistence through relationships they set up with other organizations (Jones & Corral de Zubielqui, 2017). The resources could be physical, financial, human, technological, material, or tangible and intangible as knowledge (Jones & Corral de Zubielqui, 2017). Companies look for cooperation agreements to explore external sources of knowledge in their pursuit of innovation in products and processes (Arvanitis et al., 2008; Medda, 2020; Stejskal et al., 2016) and to have adequate external knowledge to complete the internal one. Thus, not all types of external sources of collaboration are suitable for companies (Medda, 2020).

Companies should use their resources to achieve knowledge and develop the necessary capabilities (Clausen, 2013). Jones & Corral de Zubielqui (2017) expose that companies' sustainability could come from innovation and U-I cooperation that grown-up is associated with the need for innovation. According to Fischer & Varga (2002), several factors led to innovation, particularly the accelerated technological development level of our days, the increasing complexity and varieties of knowledge, and the need to share R&D. On the other hand, the traditional role of universities is changing to generate and disseminate knowledge directly connected with economic development (Segarra-Blasco & Arauzo-Carod, 2008). The U-I cooperation consists of a complex correspondence process between partners and factors such as companies' specific relational characteristics, institutional factors, and the specific type of knowledge that play a central role in establishing such cooperation (Slavtchev, 2013). The studies of the determinants that allow U-I cooperation are crucial (Aiello et al., 2019; Arvanitis,

Sydow & Woerter, 2008; Berbegal-Mirabent et al., 2015). Thus, there has been a significant increase in this research topic (Etzkowitz & Leydesdorff, 2000). For example, Schartinger et al. (2002) studied the importance of the sector of activity in the development of U-I cooperation. They concluded that U-I cooperation is more critical in industries based on science and technology. Slavtchev (2013) also analyzed geographical proximity and tacit knowledge as factors to consider for U-I cooperation. Maietta (2015) identified geographical proximity and training programs as factors that affect product innovation. Bellucci & Pennacchio (2016) examined the influence of transnational differences in explaining the characteristics of innovation systems and the role of universities. Another determinant that has been an object of study to understand U-I cooperation is its organizational characteristics and geographic location (Berbegal-Mirabent et al., 2015).

4.2.2. Hypotheses and Conceptual Model

4.2.2.1. Companies' size and U-I cooperation

According to Rõigas et al. (2018), the companies' size is the most analyzed variable determinant in U-I cooperation. The company's size determines the type of cooperation established to innovate (Cristo-Andrade & Franco, 2019). For Tether (2002), smaller companies have fewer internal resources. Also, small and innovative companies have more difficulty finding R&D partners when compared to the big ones (Segarra-Blasco & Arauzo-Carod, 2008). On the other hand, larger companies need and develop more complicated innovation strategies (Segarra-Blasco & Arauzo-Carod, 2008). When companies build cooperation with universities, large companies are generally more likely to cooperate (Aiello et al., 2019; Fontana et al., 2006; Mohnen & Hoareau, 2003; Tether, 2002). One of the reasons for that is that large companies have more internal resources and are more likely to set up partnerships with universities. It occurs because they are more aware of the university's capabilities. On the other hand, large companies are more likely to attract potential partners, have ongoing R&D programs, and set aside a budget for developing cooperation partnerships (Mohnen & Hoareau, 2003). Thus, companies' cooperation with universities is positively related to their size (Capron & Cincera, 2003; Mohnen & Hoareau, 2003; Tether, 2002). However, Rõigas et al. (2018) considered that a company's size is not a determining factor in analyzing cooperation with foreign universities since both small and large companies cooperate. Also, several other studies found that the company's size is an insignificant determining factor when

companies cooperate with universities (Eom & Lee, 2010; Fernández López et al., 2015; Okamuro & Nishimura, 2013).

So, the present study formulates the following hypotheses based on the existing research:

H1: Larger companies are more likely to cooperate with universities:
a) of the same country;
b) from another European Union (EU) country;
c) another country out of the EU.

4.2.2.2. Innovative Activities and U-I cooperation

R&D is fundamental for companies' acquiring technological knowledge (Hall, Mairesse, & Mohnen, 2010). Thus, internal capabilities and external cooperation are complementary activities in the innovation process (Powell, Koput, & Smith-Doerr, 1996). According to Fischer & Varga (2002), the greater the internal research capacity, the greater the likelihood of cooperation with universities. Companies can absorb information, especially that developed outside the company (Cohen & Levinthal, 1990), reaching that competitive advantage, namely through innovation (Hall et al., 2010). Thus, companies with innovative activities tend to be more interested in cooperation with universities (López, Astray, Pazos, & Calvo, 2015) because they feel the need to be connected to basic research (Mohnen & Hoareau, 2003).

The innovative capabilities of companies depend on their internal R&D effort, as well as the external knowledge they can acquire (Cohen & Levinthal, 1990). In in-house research, skills were considered an essential and significant determining factor for proving partnerships with universities (Busom & Fernández-Ribas, 2008; Fischer & Varga, 2002) of the same country or from another European country (Rõigas et al., 2018). In addition to internal R&D activities, companies also develop external sources of innovation and or acquire external R&D, machinery, equipment, and software (Capron & Cincera, 2003; Jose Madeira Silva et al., 2014; Rõigas et al., 2018; Tether, 2002). Still, external knowledge is a significant determinant factor when companies cooperate with universities (Volpi, 2014), whether national or from another country (Rõigas et al., 2018). According to Rõigas et al. (2018), companies that invest more in machinery will have a greater propensity to establish partnerships with other agents, namely suppliers and consortium members. Regarding this determinant, cooperation with universities will depend on the innovation activity that companies carry out. Companies that invest more in machinery, from Germany and Hungary, cooperate less

with universities, regardless of their location. Portuguese-based companies are more interested in cooperating with foreign universities; companies in Spain and Lithuania are more likely to cooperate with local universities (Rõigas et al., 2018).

For Tether (2002), acquiring technology developed externally is a significant determinant for cooperation. However, this factor is not determinant for establishing cooperation with universities in high-tech UK companies.

Training programs are also a factor that affects innovation and cooperation. Companies with low absorptive capacity will be those that will have a greater propensity to cooperate with universities, especially local ones, to provide industry research, experiences, and training (Maietta, 2015).

In consequence, the followings research hypotheses are formulated:

H2: Companies with innovative activities in-house R&D are more likely to cooperate with universities:

a) of the same country;

b) from another EU country;

c) another country out of the EU.

H3: Companies with innovative activities in external R&D are more likely to cooperate with universities:

a) of the same country;

b) from another EU country;

c) another country out of the EU.

H4: Companies with innovative activities in the acquisition of machinery are more likely to cooperate with universities:

a) of the same country;

b) from another EU country;

c) another country out of the EU.

H5: Companies with innovative activities in training are more likely to cooperate with universities:

a) of the same country;

b) from another EU country;

c) another country out of the EU.

4.2.2.3. Exportation and U-I cooperation

According to Busom & Fernández-Ribas (2008), there is a link between innovation and export performance. Exporting companies face intense international competition, with more significant pressures to innovate. Consequently, they must have well-defined R&D strategies (Aiello et al., 2019). Thus, the competitiveness of companies in international markets is a good indicator of their innovative capabilities. On the other hand, exporting companies have more developed contact networks than those that do not export, making cooperation with other organizations more likely (Salomon & Shaver, 2005).

Exporting companies need more information and knowledge acquired through cooperation with universities (Altomonte, Aquilante, Békés, & Ottaviano, 2013). Establishing this U-I link makes it possible to develop knowledge transfer activities and improve companies' innovative performance (Arvanitis, Sydow, & Woerter, 2008). Exportation could also be another determinant of cooperation. Companies that export are more likely to establish U-I cooperation activities (Aiello et al., 2019; Volpi, 2014), mainly if they do it with foreign universities because they offer international knowledge that firms need (Rõigas et al., 2018).

Additionally, those companies that belong to high-tech and knowledge-intensive sectors are more likely to participate in innovative activities obtained through U-I cooperation (Bellucci & Pennacchio, 2016).

In consequence, the present hypotheses are formulated:

> **H6:** Companies that export are more likely to cooperate with the universities:
> **a)** of the same country;
> **b)** from another EU country.
> **c)** another country out of the EU.

4.2.2.4. Public Funds and U-I cooperation

Companies with access to public funds are more likely to develop R&D activities (Aiello et al., 2019; Segarra-Blasco & Arauzo-Carod, 2008), for example, those that obtained financial incentives from the government to do it (Aiello et al., 2019; Rõigas et al., 2018). They lead to establishing partnerships with universities and developing innovations (Cassiman & Veugelers, 2002). According to Vlasova (2020), in Russia, the cooperation occurs essentially with universities of that country because the government

has developed a set of legal requirements for obtaining very demanding state support when cooperating with foreign partners, including universities.

The governments should focus their public policies on promoting U-I cooperation (Segarra-Blasco & Arauzo-Carod, 2008) because they positively influence new products and innovation (Odei et al., 2020). Financial support from the national government and the EU can be an additional factor in developing U-I cooperation. It allows filling the lack of financial resources needed to establish university links (Seppo et al., 2014).

Local/regional government funds influence companies' cooperation (Junior & Odei, 2018; Odei et al., 2020). There is also a positive effect of central government funds (Rõigas et al., 2018) and EU funds on the cooperation with universities (Odei et al., 2020; Rõigas et al., 2018; Segarra-Blasco & Arauzo-Carod, 2008). Access to these incentives increases the likelihood that companies will cooperate with national and foreign universities (Rõigas et al., 2018).

So, the following research hypotheses are proposed:

H7: Companies that obtained local/regional funds are more likely to cooperate with universities:

a) of the same country;

b) from another EU country;

c) another country out of the EU.

H8: Companies that obtained central government funds are more likely to cooperate with universities:

a) of the same country;

b) from another EU country;

c) another country out of the EU.

H9: Companies that obtained EU funds are more likely to cooperate with universities:

a) of the same country;

b) from another EU country;

c) another country out of the EU.

4.2.2.5. Conceptual Model

This study aims to identify the influence of a company's size, innovative activity, exportation, and access to public funds in U-I processes.

Concerning the analysis of the data made available in the CIS, it was possible to identify three groups of universities with which companies could establish cooperation, namely a) universities of the same country, b) universities of another EU country, and c) universities out of the EU.

The conceptual framework, exposed in figure 4.1, postulates that the size, the innovative activities, the exportation, and the obtention of public funds are positively related to the cooperation that companies set up with the universities.

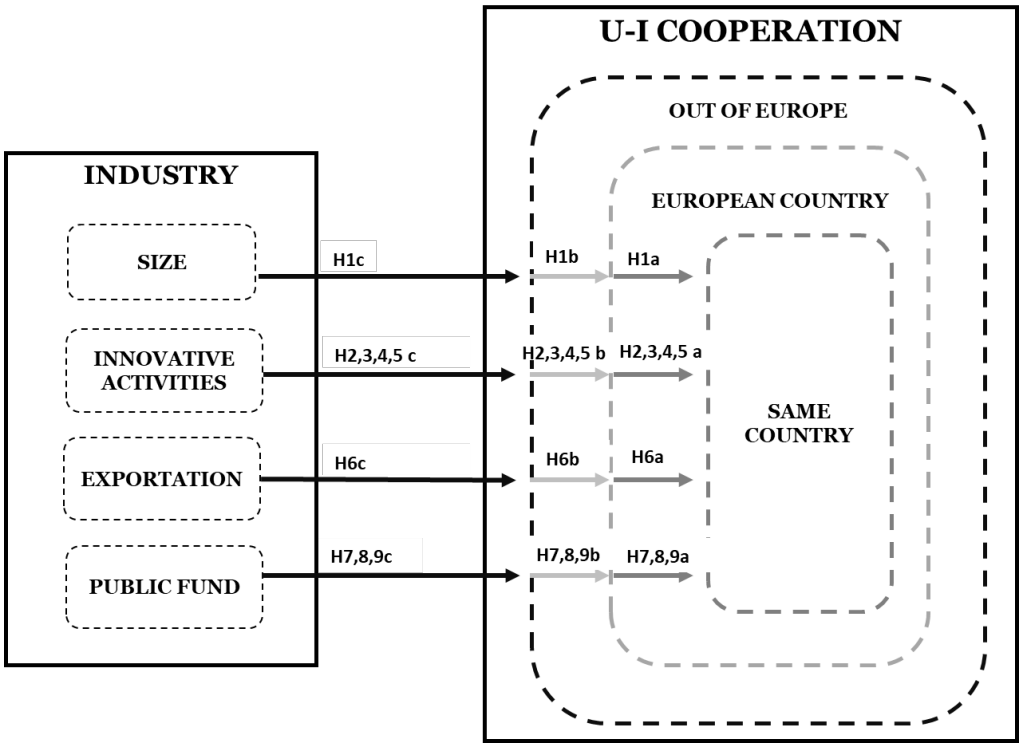


Figure 4.1 - Conceptual model of the determinants of U-I cooperation

4.3. Methodology

4.3.1. Data

The empirical analysis of this research uses secondary data from the Community Innovation Survey (CIS). The data of this study refer to the companies included in the CIS 2016. Each observation period relating to three years (beginning of 2014 until the

end of 2016) consists of the countries for which the microdata is available. Companies that did not develop any innovative activity during this period were excluded, and 28743 observations were analyzed. The database provides information about different interactions between innovative firms and other research institutions, namely universities. It also holds information about some characteristics of companies. Several authors resorted to the CIS database for their research and analysis over the years (Busom & Fernández-Ribas, 2008; Capron & Cincera, 2003; Mohnen & Hoareau, 2003; Rõigas et al., 2018; Segarra-Blasco & Arauzo-Carod, 2008).

The questionnaire was implemented in 15 European countries, but only data from 14 of them were used. Cyprus data was not used because it did not include all the information necessary to estimate the conceptual model. The responses of companies belonging to the database in the period mentioned were analyzed, namely those from Germany (2655), Bulgaria (2144), Croatia (892), Spain (9820), Estonia (422), Greece (1111), Hungary (1339), Latvia (353), Lithuania (1067), Norway (2303), Portugal (3395), Republic Czech (2197), Romania (576) and Slovakia (469), in a total of 28743 companies.

4.3.2. Variables

Different dichotomous variables were considered to assess the hypotheses formulated, which are presented in Table 4.1. The CIS shows the various partners with which companies can cooperate. This study will analyze the cooperation with the universities or other higher education institutions. The dependent variable refers to the multiple modes of cooperation that companies can establish with universities, namely in the same country, another EU country, or outside the EU.

The CIS allows access to a series of objective and measurable variables that capture some characteristics of companies. The explanatory variables used are also dichotomous. Variables like companies' size, innovative activities, exportation, and the obtention of public funds are analyzed.

Regarding innovative activities, it contains the analysis of several variables, namely a) in-house R&D - research and development activities are undertaken by the enterprise to create new knowledge or to solve scientific or technical problems (include software development in-house that meets this requirement); b) external R&D - the enterprise contracted-out R&D to other enterprises (include enterprises in the own group) or to public or private research organizations; c) Acquisition of machinery, equipment,

software & buildings - acquisition of advanced machinery, equipment, software and buildings to be used for new or significantly improved products or processes; d) Training for innovative activities - in-house or contracted out training for personnel specifically for the development and/or introduction of new or significantly improved products and processes.

This study includes control variables to avoid endogeneity and omitted-variable bias problems. The control variables inserted in the analysis influence the U-I cooperation - belonging to a group and economic activities. Thus, the binary variable assumes the value 0 if the company does not belong to a group and 1 if it does. Finally, 21 variable control dummies were included based on the double-digit NACE 2 rankings, although their coefficients are omitted from our tables.

Table 4.1 - Summary of variables used in the study

Name of variable	Variables Code	Description of Variable
Dependents Variables		
Cooperation with universities of the same country	Co61	1 = if the firm has cooperated with universities or other higher education institutions of the same country 0 = if the firm has not cooperated with universities or other higher education institutions of the same country
Cooperation with universities from another EU country	Co62	1 = if the firm has cooperated with universities or other higher education institutions of another EU country 0 = if the firm has not cooperated with universities or other higher education institutions of another EU country
Cooperation with universities outside the EU	Co_66 (Co63 a Co65)	1 = if the firm has cooperated with universities or other higher education institutions of a country outside the EU 0 = if the firm has not cooperated with universities or other higher education institutions of a country outside the EU
Explanatory Variables		
Size	SIZE	1 = if the number of employees of the firm varies between 10 and 249 0 = if the number of employees of the firm is more than 249
Innovative Activities		
In-house R&D	RRDIN	
External R&D	RRDEX	
Acquisition of machinery, equipment, software & buildings	RMAC	1 = if the company carried out innovative activities 0 = if the company did not carry out innovative activities
Training for innovative activities	RTR	
Exportation	MAR_OC	1 = if the company sold goods and/or services to other countries 0 = if the company did not sell goods and/or services to other countries
Public Funds		
Local/ regional funding	FUNLOC	1 = if the firm had access to public fund 0 = if the firm did not have access to public fund
Central government funding	FUNGMT	
European Union funding	FUNEU	
Control Variable		
Part of an enterprise group	GP	1 = if the firm was part of an enterprise group

		0 = if the firm was not part of an enterprise group
Economic Activities (21 categories; i=1 to 21)	NACEi	1 = if the firm is from the economic activities i 0 = if the firm is not from the economic activities i

Figure 4.2 shows the different cooperation established with universities and if they took place with universities in the same country, or with another EU country, or with universities outside the EU. The cooperation that most occurred was the cooperation with universities in the same country, with about 4228 (14.7%) observations.

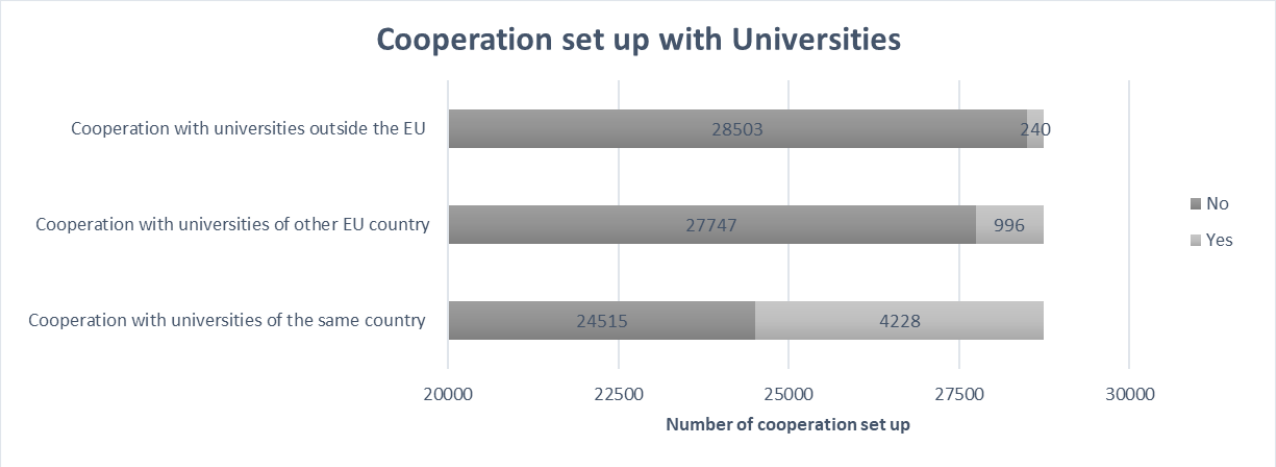


Figure 4.2 - Cooperation set up with universities

Table 4.2 shows the frequencies of the explanatory variables. Regarding the company's size, it is possible to verify that those with between 10 and 249 employees represent 83.8% of the observations. Concerning innovative activities, the most performed were the in-house R&D with 14931 (51.9%) observations. Finally, it is possible to verify that exportation is a characteristic of most companies in the sample, with 70.5% of the observations. Finally, the analysis of the access to public funds variable shows that the central government resources will be the most obtained by companies, with 6835 (23.8%) observations.

Table 4.2 - Frequencies of the variables

		Frequency	Percentage
Size	10-249	24095	83.8
	+249	4648	16.2
IA - In-house R&D	Yes	14931	51.9
	No	13812	48.1
IA - External R&D	Yes	7133	24.8
	No	21610	75.2
IA - Acquisition of machinery, equipment, software & buildings	Yes	13892	48.3
	No	14851	51.7
IA - Training for innovative activities	Yes	9926	34.5
	No	18817	65.5
Exportation	Yes	20259	70.5
	No	8484	29.5
Local/ regional funding	Yes	3016	10.5

	No	25727	89.5
Central Government	Yes	6835	23.8
	No	21908	76.2
European Union funding	Yes	3777	13.1
	No	24966	86.9

4.3.3. Econometric Methods

The multiple regression analysis is a dependence technique whose objective is to use the independent variables to predict the dependent variable (Hair et al., 2014). A logistic regression model was used since the dependent variable takes on a binary character, assuming a value equal to 1 if the companies cooperate with universities and 0 if there was no cooperation with universities. In turn, the explanatory variables are also dichotomous, assuming a value of 1 when the company had more than 249 employees, or when it had any innovative activity, export, or access to any public fund. On the other hand, the variable's value 0 exists when the company had between 10 and 249 employees, had no innovative activities, did not have export, or did not have access to any financing. Thus, the use of this regression model makes even more sense.

The database used contains a very high number of observations and comprises data from 14 countries. The assumption that observations are independent of the logistic regression model could be compromised since observations are collected based on countries, which may cause a clustering effect. To control for some bias in the model due to observations selected by country, it was necessary to adjust the cluster (country) effect in the estimation of standard errors of parameter estimates. For this purpose, the cluster-robust standard errors method of estimating the standard errors of the parameter estimates was used. On the other hand, control variables were also used related to companies, such as the sector of activity and belonging or not to a business group. Therefore, the following model is proposed, in it, the company's size, the innovative activities, the exportation, and getting access to different public funds influences the type of U-I cooperation established:

$$P(Y_i = 1) = \frac{1}{1+e^{-f(x)}}, \quad (1)$$

Where

$$f(x) = \beta_0 + \beta_1 \text{Size} + \beta_2 \text{RRDIN} + \beta_3 \text{RRDEX} + \beta_4 \text{RMAC} + \beta_5 \text{RTR} + \beta_6 \text{MAR\_OC} + \beta_7 \text{FUNLOC} + \beta_8 \text{FUNMGT} + \beta_9 \text{FUNEU} + \beta_{10} \text{GP} + \sum_{i=1}^{21} \beta_{6i} NACE_i + \varepsilon$$

In the logistic regression equation (1), the value of P means the probability of cooperation occurs, that is, the value of Yi is 1. Cooperation refers to the dependent variables, in this case, U-I cooperation - of the same country, or another EU country, or outside de EU, and have the following variables: Y_1 - cooperation with universities of the same country; Y_2 - cooperation with universities of another EU country; Y_3 - cooperation with universities outside the EU. The explanatory variables refer to the determinants, namely SIZE is companies' size, the innovative activities: RRDIN is in-house R&D; RRDEX is external R&D; RMAC is the acquisition of machinery, equipment, software & buildings; RTR is training for innovative activities, MAR_OC is the exportation, and the type of funds obtained during the cooperation: FUNLOC is local/regional funds; FUNMGT is central government funds, and FUNEU is EU funds. Finally, the control variables are GP (belonging to a group), and NACE (economic activities).

4.4. Results

This paper aims to measure the influence of the determinant's companies' size, innovation activities, exportation, and government funds on the propensity to cooperate with national and foreign universities. After implementing the logistic regression model for the 28743 available observations, the results are in tables 4.3, 4.4, and 4.5.

Regarding the results listed in tables 4.3, 4.4, and 4.5, and the value of the Omnibus Test of Models Coefficients ($p < .001$), it is possible to verify that at least one of the explanatory variables - company's size, innovative activities, exportation, and public funds - in the regression model, contribute to explain the process of cooperation established with universities. So, the results reject the hypothesis that all coefficients are null. The -2 log-likelihood statistic value confirms the models' general significance compared to the null model. On the other hand, the results of Wald's statistics show that all the explanatory variables are significant to explain the odd of existing cooperation established with universities of the same country, or from another UE country, or another country outside the EU. All values obtained in each scenario are significant ($p < .001$).

Table 4.3 - Logistic regression - Influence of the various determinants on cooperation with universities of the same country

	Cooperation with Universities of the same country			
	B	S.E.	Wald	Exp (B)

Explanatory Variables				
SIZE	0.696***	0.110	6.31	2.007
RRDIN	1.303***	0.131	9.92	3.679
RRDEX	0.999***	0.051	19.64	2.718
RMAC	-0.236*	0.119	-1.98	0.789
RTR	0.247**	0.071	3.46	1.281
MAR_OC	0.191*	0.090	2.12	1.211
FUNLOC	0.283*	0.133	2.13	1.328
FUNMGT	1.094***	0.146	7.50	2.987
FUNEU	0.996***	0.108	9.20	2.708
Control Variables				
GP	0.223*	0.104	2.14	1.250
NACE			Included	
Constant	-3.266***	0.187	-17.45	0.038

Omnibus Tests of Models Coefficients	6332.21***
-2 Likelihood-ratio test	-8838.1143

****p < 0.001; ** p < 0.005; *p<0.05*

As shown in table 4.3, the variables size, all the innovative activities, all the public funds, and the exportation significantly affect the U-I cooperation with universities of the same country. On the other hand, all variables positively affect the cooperation process except the variable RMAC - Acquisition of machinery, equipment, software & buildings, which has a significant negative effect (β= -0.236; p <.05). On the other hand, there is less likelihood of U-I cooperation in a company that invests in acquiring machinery, equipment, software, and buildings than in a company that does not. Thus, the odds of U-I cooperation with universities in the same country is 2.007 times greater when companies are larger (with more than 249 employees), 3.679 times greater when existing in-house R&D, 1.211 times greater when companies export, and 2.987 times greater when companies obtain funds from the central government, compared to those that did not obtain it, keeping the other variables constant.

Consequently, the results support all the hypotheses H1a, H2a, H3a, H4a, H5a, H6a, H7a, H8a, and H9a. Companies with a larger size, with innovative activities, that export and obtain public funds are more likely to cooperate with universities of the same country.

Table 4.4 - Logistic regression - Influence of the various determinants on cooperation with universities of another EU country

	Cooperation with Universities of another EU country			
	B	S.E.	Wald	Exp (B)
Explanatory Variables				

SIZE	0.824***	0.117	7.01	2.279
RRDIN	1.740***	0.281	6.19	5.699
RRDEX	0.726***	0.109	6.67	2.066
RMAC	-0.132	0.154	-0.86	0.877
RTR	0.190*	0.091	2.09	1.209
MAR_OC	0.503**	0.158	3.17	1.653
FUNLOC	0.345*	0.169	2.04	1.412
FUNMGT	0.759***	0.128	5.94	2.137
FUNEU	1.989***	0.251	7.91	7.308
Control Variables				
GP	0.319**	0.093	3.44	1.375
NACE			Included	
Constant	-7.585***	0.300	-25.27	0.001
Omnibus Tests of Models Coefficients		2810.09***		
-2 Likelihood-ratio test		-2919.0929		

****p < 0.001; ** p < 0.005; *p<0.05*

As shown in Table 4.4, the company's size, the R&D and training innovative activities, exportation, and all the public funds significantly affect the cooperation with universities of another EU country. On the other hand, all variables positively affect the cooperation process. The RMAC variable - Acquisition of machinery, equipment, software & buildings - has no significant impact on cooperation with the universities of another European country. Thus, the odds of cooperation with universities of another EU country is 2.279 times greater when companies are larger (with more than 249 employees), 5.699 times greater when they have in-house R&D, 7.308 times greater when they obtain funds from the EU, compared to those that did not get it, keeping the other variables constant. Consequently, the results support the hypotheses H1b, H2b, H3b, H5b, H6b, H7b, H8b, and H9b, which hold that companies with a larger size, with innovative activities, that export, and that obtain public funds are more likely to cooperate with universities of another EU country. The results do not support the hypotheses H4b, so the acquisition of machinery, equipment, software & buildings are not significantly related to U-I cooperation with universities of another EU country.

Table 4.5 - Logistic regression - Influence of the various determinants on cooperation with universities outside the EU

	Cooperation with Universities outside the EU			
	B	S.E.	Wald	Exp (B)
Explanatory Variables				
SIZE	1.022***	0.180	6.67	2.778
RRDIN	1.988***	0.337	5.90	7.298
RRDEX	1.055***	0.261	4.04	2.872

RMAC	-0.072	0.339	-0.21	0.486
RTR	0.126	0.253	0.50	1.35
MAR_OC	0.483*	0.182	2.65	1.620
FUNLOC	0.448**	0.129	3.47	1.565
FUNMGT	0.659***	0.139	4.73	1.933
FUNEU	1.044***	0.191	5.47	2.841
Control Variables				
GP	0.419**	0.136	3.09	1.520
NACE			Included	
Constant	-8.891***	0.791	-11.23	0.000

Omnibus Tests of Models Coefficients	686.13***
-2 Likelihood-ratio test	-1041.2129

****p < 0.001; ** p < 0.005; *p<0.05*

Table 4.5 shows that the size, exports, and public funds significantly affect the cooperation with universities outside the EU. In this case, and regarding innovative activities, it is possible to verify that only the variables of in-house R&D and external R&D have a positive effect on the cooperation process with universities outside the EU. The variables RMAC - acquisition of machines, equipment, software, and buildings and RTR - training for innovative activities, do not significantly impact the cooperation process. Thus, the odds of cooperation with universities outside the EU are 2.778 times greater when companies are larger (with more than 249 employees), 7.298 times greater when they have in-house R&D, and 2.841 times greater when they obtain funds from the EU, compared to those that did not get it, keeping the other variables constant.

Consequently, the results support the hypotheses H1c, H2c, H3c, H6c, H7c, H8c, and H9c, which hold that companies with a larger size, with in-house and or external R&D, that export, and that obtain public funds, are more likely to cooperate with universities outside the EU. The results do not support the hypotheses H4c and H5c. So, the variables acquisition of machinery, equipment, software & buildings, and training for innovative activities are not significantly related to U-I cooperation with universities outside the EU.

4.5. Discussions and Implications

4.5.1. Discussions

TRC is an essential basis for companies, as it allows companies to obtain resources that enable them to survive, acquire competitive advantages, and grow (Ayala & González-Campo, 2015). So, companies must develop U-I cooperation (Franco & Haase, 2015; Grant, 1991). Analyzing the determinants that influence cooperation is essential to understanding which companies cooperate to achieve innovation (Aiello et al., 2019; Busom & Fernández-Ribas, 2008; Rõigas et al., 2018; Segarra-Blasco & Arauzo-Carod, 2008).

Companies have limited resources to develop their activities. Thus, the U-I cooperation allows them access to vital resources, technology, and new markets. The current study investigates the influence of companies' size, innovative activities, exportations, and the effect of public funds on the establishment of cooperation with universities – of the same country, with another EU country, or with a country outside the EU. Despite the number of scientific studies developed based on this theme, there are current research calls for additional research on this topic (Aiello et al., 2019; Segarra-Blasco & Arauzo-Carod, 2008). This study attempts to understand the U-I cooperation, namely, identifying which companies cooperate the most and their characteristics. On the other hand, it intended to compare companies that develop U-I cooperation with universities in the same country and foreign ones, more specifically with another EU country and universities outside the EU.

4.5.2. Implications

4.5.2.1. Theoretical Implications

This article provides a substantial number of theoretical contributions to the U-I cooperation literature. First, it confirms that cooperation is essential for companies because it allows them to obtain resources, knowledge, and competitive advantages that they would not otherwise get. From that perspective, this study reinforces that TRC is a crucial framework for managing companies, as they may not have the means and resources necessary to innovate and compete. Thus, they will need to cooperate to acquire them. However, not all companies are capable or have the correct characteristics. There are several external resources that a company can get with U-I cooperation to achieve innovation. Companies have significant benefits in developing U-I cooperation (Etzkowitz & Leydesdorff, 2000) because they obtain new knowledge and innovation (Stejskal et al., 2016). Since that, this study confirms the results of

Grant (1991), who affirms that the resources are vital for the companies, although to receive them, the companies have to cooperate.

This research demonstrates that the analysis of cooperation determinants is fundamental to understanding and characterizing the companies interested in developing U-I cooperation. In addition, it supports the significant role of the variables size, in-house R&D, external R&D, exportation, and public funds as determinants to establish U-I cooperation with universities of the same country, another EU country, or universities outside the EU. However, this research confirms that the acquisition of machinery, equipment, software & buildings has no significant effect on the development of U-I cooperation when it occurs with universities out of the country, whether from another EU country or outside the EU. The variable training for innovative activities has no significant effect on the development of U-I cooperation when it occurs with universities outside the EU. These may happen because differences in languages and cultures exist between both organizations, and it is not easy to interpret the mutual and the product market needs. Another explication is that companies that incorporate high levels of R&D in their activity lead to a lower propensity for U-I cooperation. On the other hand, universities could not offer the type of knowledge that firms need.

Therefore, this study develops the TRC as it identifies and characterizes the companies most prone to U-I cooperation, explaining the need and relevance of their existence. Finally, this study responds to a call in the literature to further research U-I cooperation and the effects of determinants on the process cooperation (Aiello et al., 2019). Thus, the study analyzes the determinants that influence cooperation established with national and foreign universities.

4.5.2.2. Managerial Implications

The need to grow and innovate leads companies to develop U-I cooperation since universities are concerned with teaching and the business community. Thus, this study analyzes the essential determinants for companies to establish U-I cooperation processes with universities from the same country or another one.

Company's size is a positive and statistically significant determinant in the cooperation process. Large companies are more likely to establish U-I cooperation with national and foreign universities than smaller ones. To compensate for that gap, smaller companies must become aware of universities' capacities and skills and increase the U-I cooperation. They need to introduce modern management practices to achieve

innovation and gain quick, cost-effective, and sustainable competitive advantages, what they will earn if they develop this type of cooperation.

Another determinant analyzed as an influencing factor in U-I cooperation is innovative activities. Internal R&D and external R&D are positive and statistically significant determinants of U-I cooperation, both with national and foreign universities. Thus, companies must continue to invest in internal and external R&D. As the knowledge acquired externally complements the internal competencies, companies that intend to cooperate with universities must also invest internally in the absorption capacity that allows the efficient exploitation of the production of external knowledge. On the other hand, companies should not invest in machinery and training as a relevant factor in establishing U-I cooperation. This determinant is not relevant, especially when cooperation is with universities outside the EU.

Regarding the export variable, this is a significant factor in U-I cooperation. Therefore, companies should consider it. The existing sharing between companies during an export process can bring significant benefits to the companies involved, namely in sharing information, knowledge, and even technologies.

In addition, public policies play a crucial role in promoting U-I cooperation, providing public resources to encourage private R&D. All public funds analyzed – local, central government, or EU - positively and significantly influence the U-I cooperation. Thus, companies should be attentive and have access to national and international public funds to increase U-I cooperation and development in R&D.

These results also have important political implications. The country's development depends on the development of organizations, so governments will have every interest in increasing U-I cooperation. Thus, governments should promote and disseminate policies that increase U-I cooperation and develop more public funds to support cooperation. Thus, in addition to encouraging companies to cooperate more with universities, especially those that do not yet, governments should also develop laws supporting U-I cooperation. Otherwise, the establishment of partnerships between governments could be an approach to increase cooperation with foreign universities, not only through the allocation of public funds but also by reducing taxes or incentives for R&D.

The use of information developed by universities, and the U-I cooperation, depends on the characteristics of companies. Thus, the impact of academia relies not only on the quality of research but also on the companies' abilities, activities, and motivations. It is

fundamental that universities disseminate their R&D work and share their skills and resources with companies. On the other hand, universities must identify companies' current and future needs to cooperate.

4.6. Conclusions, limitations, and future research directions

This paper analyzes the companies' size, innovation activities, exportation, and government funds on the propensity to collaborate with national and foreign universities. This research reveals some similarities and differences between companies that cooperate with national and foreign universities. The results strongly support that the size of companies and innovative activities directly related to R&D, exportation, and public funds influence the realization of U-I cooperation. Thus, these determinants significantly explain U-I cooperation with national and foreign universities. This is in line with the studies carried out by Aiello et al. (2019), Rõigas et al. (2018), López et al. (2015), Segarra-Blasco & Arauzo-Carod (2008), Fontana et al. (2006), Mohnen & Hoareau (2003), Fischer & Varga (2002), and Tether (2002). Larger companies with innovative activities that export and those that obtained public funds will be more likely to cooperate with universities. However, there is a difference in U-I cooperation with national and foreign universities when getting public funds. Thus, companies' obtention of central government funds is the most significant in explaining the existence of U-I cooperation with universities in the same country. Otherwise, EU funds are the most important in demonstrating the U-I cooperation with foreign universities

On the other hand, training programs have a relevant and significant role in explaining the U-I cooperation of the same or another EU country. However, when this cooperation is with a university outside the EU, this factor is no longer relevant. This confirms the results of Maietta (2015), where companies cooperate with universities located nearby to have access to innovations, experiences, and training. Thus, it will be up to universities to assess companies' concrete needs to offer more targeted and specific training programs. The purchase of machinery has a significant, albeit negative, impact on cooperation with universities in the same country. Thus, the more a company invests in machinery, the less likely it will establish U-I cooperation, which confirms the result of Rõigas et al. (2018). Cooperation occurs when companies need more knowledge from universities when developing product innovation and not so

much in processes. The acquisition of machinery by companies is no longer relevant and significant when cooperation is with universities of another EU country or outside the EU.

This analysis is essential to analyze which companies are most likely to develop the U-I cooperation. Universities need to build knowledge, technologies, and research that will enable them to attract companies that are still not very motivated to cooperate. On the other hand, and since cooperation allows for developing countries, it will be necessary for governments to establish policies and efforts to promote U-I cooperation. Additionally, governments will need to stimulate innovation in small companies developed through U-I cooperation.

However, this research has limitations related to data obtained from the CIS database. Namely, the lack of employees per company in all countries involved in the study and the countries included in it. Thus, future studies can be developed in this context, making a comparative analysis between EU countries and those outside the EU. Finally, only technologically innovative companies respond to CIS concerning their cooperation partners. Thus, our sample is biased towards technologically innovative companies.

It would also be essential to assess other determinants that may be considered relevant in the analysis of U-I cooperation. Otherwise, it would be interesting to carry out a comparative analysis of U-I cooperation between European and non-European countries to investigate possible discrepancies in the explanatory determinants of cooperation. On the other hand, a study could be carried out with the objective of analyzing which are the determinants that allow explaining U-I cooperation in companies that are not technologically innovative.

Chapter 5. The moderating effect of absorptive capacity on the relationship between knowledge transfer and innovative capacity

Abstract

The pressure felt and experienced by companies in an increasingly global competitive market forces them to be holders of innovation. In this context, partnerships are established with universities as they hold and support the transfer of knowledge.

This study investigates the effects of knowledge transfer (KT) at the national and international level on companies' innovative capacity - product and process - and the moderating effect of absorptive capacity (AC) between KT and innovative capacity. The methods used are logistic regression and PROCESS software for the sample of 12808 observations from 14 countries of the Eurostat Community Innovation Survey dataset. The results confirm that KT at the national and international levels is significant and represents a relevant source for innovative activities developed by companies. This research shows that AC should be considered a moderating variable when U-I cooperation is with universities of the same country because it impacts the relationship between national KT and innovative capacities - products and processes. However, the same is not noticeable in U-I cooperation with universities from another EU country because AC does not significantly affect the relationship between international KT and innovations, especially in terms of the product.

In addition, this study provides substantial theoretical contributions on the subject and more information about the importance of KT, namely through University-Industry cooperation.

Keywords: U-I Cooperation, Innovation, Knowledge transfer, Innovative Capacity, Absorptive Capacities.

"*Furthermore, universities are now being required to demonstrate their legitimacy to external stakeholders, including industry and society at large. This means that the university and the production and dissemination of knowledge are currently perceived as being at a crossroad.*" (Compagnucci & Spigarelli, 2020, pp. 18).

5.1. Introduction

The rise of the knowledge economy, globalization, and the various financial and environmental crises are unprecedented challenges for all (Rubens et al., 2017). Thus, the multiple stakeholders with which companies can establish partnerships, namely politicians, companies, science, and social society, have gained significant importance (Di Maria et al., 2019). So, in response to the growing pressure on the environment, companies prioritize innovation (de Marchi & Grandinetti, 2013; Fernández-López et al., 2019). They will have to maintain closer relationships with other actors to carry out knowledge transmission (Guan & Liu, 2016). This cooperation can occur with local, regional, national, and international actors of innovation systems (Stojčić, 2021).

The scientific community, including universities, is increasingly emerging as an important organizational actor (Di Maria et al., 2019). To help society in an increasingly complex environment, universities have realized that their role goes far beyond education (Adams, Jeanrenaud, Bessant, Denyer, & Overy, 2016), prioritizing the production and dissemination of knowledge transfer (KT) (de Marchi & Grandinetti, 2013). In this sense, universities represent a relevant source of knowledge (Abbate, Cesaroni, & Presenza, 2021). Thus, the KT between University-Industry (U-I) is considered crucial for companies' competitiveness (Figueiredo & Fernandes, 2020) because it permits companies' innovation activities (Medda, 2020; Wang, Li, & You, 2020). According to Jin, Wu, & Chen (2011), U-I cooperation crosses national borders. Modern innovation systems involve cooperation beyond national borders. Although the proximity between the agents involved in cooperation can be considered beneficial for KT, this is not an essential factor (Stojčić, 2021). U-I cooperation is a carrier of knowledge spillovers, impacting beyond a regional scale (Ponds, van Oort, & Frenken, 2010).

The U-I cooperation allows the sharing of knowledge. However, companies need to develop their absorptive capacity (AC). AC is a crucial skill in using new knowledge (Kostopoulos et al., 2011). It improves companies' ability to manage the flow of external knowledge (Cassiman & Veugelers, 2002; Escribano et al., 2009), thus allowing to achieve the effectiveness of innovation (Cassiman & Veugelers, 2002). However, companies must be willing to learn and absorb external knowledge to solve problems and create value (Cassiman & Veugelers, 2002).

The practical relevance of collaborative innovation has stimulated a vast amount of empirical research. However, the previous studies have several limitations, namely, the analysis of a single country or a small group of countries (Eom & Lee, 2010; Stojčić, 2021);

focuses on one specific area of innovation, namely the product (Eom & Lee, 2010; Kobarg, Stumpf-Wollersheim, & Welpe, 2018); or a particular sector of activities (Abbate et al., 2021; Ciriaci, Montresor, & Palma, 2015). Thus, more studies are needed to analyze the collaborative innovation covering different countries and areas of innovation.

KT is one of the most crucial aspects of improving a company's innovation capability (Abbate et al., 2021; Wang et al., 2020). Although studies on the subject increased, understanding KT background and consequences remain unclear (Van Wijk, Jansen, & Lyles, 2008). According to Mohnen & Hoareau (2003) and Franco, Haase, & Fernandes (2014), the effects of KT on innovation, achieved by the U-I cooperation, have not yet been adequately analyzed. On the other hand, there is a lack of research into the potential effect of AC between KT and innovation capacities (Kobarg et al., 2018). It is also necessary to develop studies to explore U-I cooperation, considering different innovation outputs (Messeni Petruzzelli & Murgia, 2020). So, the following research question were formulated:

Q1 - What is the effect of knowledge transfer on the innovative activities of companies?

Q2 - What is the moderating effect of absorptive capacity in the relationship between knowledge transfer and innovation?

Consequently, the present study aims to understand the impact of KT on companies' innovative capacities. Thus, this research analyzes the influence of national and international KT on the different innovation activities of companies, namely those related to products and processes. This study also examines the moderation effect of AC on the relationship between companies' KT, national and international, and innovation activities.

The analysis relies on the data from the most recent (2016) version of Eurostat's Community Innovation Survey (CIS), the most comprehensive firm-level dataset on innovation activities in Europe. The sample with 12808 observations consists of companies that have established, at that time, a cooperation process for KT.

This article offers a valuable contribution to the literature using many countries. It provides information about the effects of KT on the innovative capacities of companies. On the other hand, it presents a comparative view of the impacts of national and international KT, namely through establishing U-I cooperation with universities of the same country and from another EU country. It also allows analyzing the moderation effect of AC in the relationship between KT - national and international - and innovative product and process activities.

The paper is structured as follows. The following section will approach the literature about the importance of KT in innovation activities. The third section describes the method and the database used, and the fourth section presents the results. Finally, section five offers the discussions and implications for academics and practitioners. The article ends with the study's conclusions, limitations, and directions for future research.

5.2. Theoretical underpinnings and hypotheses

The lack of skills and capabilities to create commercial innovations is one of the problems that companies face. The resolution will involve the sharing and acquiring resources through cooperation processes (Stojčić, 2021). Thus, companies can achieve essential additional resources for innovative activities (Ciriaci et al., 2015). In a world of global economies and constant technological changes that facilitate the KT, the real challenge for companies will be to recognize, obtain, employ and complement relevant, innovative information (De Bondt, 1997).

5.2.1. Knowledge-Based view Theory

Innovation is considered critical to companies' business value, performance, and survival (Corral de Zubielqui, Lindsay, Lindsay, & Jones, 2019). According to Chuluun, Prevost, & Upadhyay (2017), innovation creates and applies new knowledge to develop new technologies, processes, products, and services. For Borghini (2005), innovation includes finding, discovering, experimenting, and developing new technologies, products, or services with new production processes or organizational structures. Innovation is the ability to absorb information, knowledge, and external technologies by establishing partnerships with other agents such as competitors, suppliers, customers, universities, and public organizations (Badillo et al., 2017). So, to innovate, the companies must exchange materials, information, and energy with the external environment, especially knowledge (Wang et al., 2020). KT is crucial for companies' innovation process (Wang et al., 2020). This process occurs between two or more actors, individuals, or organizations and aims to allow one actor to acquire the knowledge of the other actor (Manfredi Latilla, Frattini, Messeni Petruzzelli, & Berner, 2019). For Van Wijk et al. (2008), KT is the process by which intra and inter-organizational actors exchange, receive, and are impacted by the knowledge of other actors. Christensen (2013) goes further in his definition of KT, stating that it consists of identifying existing knowledge, acquiring it to develop new ideas, or improving them to make a process/action faster, better, or safer. Thus, the KT is about achieving objectives, exploring knowledge, and acquiring and absorbing it efficiently and effectively (Christensen, 2013).

Knowledge is a precious resource for companies (Abbate et al., 2021; N. Figueiredo & Fernandes, 2020; Teece, 2000). It allows the development of the innovation process (Wang et al., 2020), and it is the most strategically significant company resource according to the knowledge-based view (KBV) theory (Grant, 1996). KBV suggests that a company's success depends on its capacity to create value in two directions: by transferring and converting knowledge externally and internally to the organization (Low & Ho, 2016). According to Grant (1996), companies must develop strategies according to their organizational capabilities closely linked to knowledge. Thus, an organization can be seen as a knowledge engine and repository, producing, storing, and implementing knowledge. Therefore, KT contributes to developing companies' competitive advantages (Szulanski, 1996) as it allows them to grow, disseminate, use, imitate, and retain resources and information (Teece, 2000). For Grant (1996), KBV is an organizational learning management concept that provides companies with strategies to achieve a competitive advantage by using and integrating knowledge. Companies must incorporate internal and external knowledge to foster successful opportunities and innovation (Liu, Chen, & Tsai, 2005). So, a company that cannot identify, assimilate, and applies new external knowledge flows will not derive any innovation (Escribano et al., 2009; Kostopoulos et al., 2011).

The innovation process is very dependent on knowledge (Ganguly, Talukdar, & Chatterjee, 2019). The link between knowledge and innovation is justified once knowledge has a direct and indirect effect on the innovation success of companies, namely by the improvement in innovation activities (Santoro, Vrontis, Thrassou, & Dezi, 2018).

Innovation in products or services encompasses a high intensity of knowledge that can lead companies to cooperate to fill gaps in information, scientific knowledge, resources, and skills (Romijn & Albaladejo, 2002). Process innovations do not lead to new products or services. Still, they reflect the necessary preconditions to produce them, requiring access to information and knowledge obtained through cooperation (Romijn & Albaladejo, 2002).

The current context has contributed to redesigning and expanding universities' missions (Rubens et al., 2017). The growing demand for teaching, research, and technology transfer led universities to be entrepreneurial (Etzkowitz & Leydesdorff, 2000). In consequence, universities develop research activities in addition to teaching. Thus, two trends emerge: an increasing dependence of the economy on knowledge production; and orienting future trends in production and knowledge to the needs of society (Zomer & Benneworth, 2011).

The role of universities as a source of knowledge is unquestionable, as researchers from the most diverse areas are focused on producing new and original knowledge (Di Maria et

al., 2019). So, companies should develop U-I cooperation to improve their innovation, productivity, and competitiveness (Atta-Owusu et al., 2021). According to Berbegal-Mirabent, Sánchez García, & Ribeiro-Soriano (2015), the KT that companies obtain from universities is considered an essential strategy for boosting business, encouraging, and developing innovation. For that reason, U-I cooperation can have multiple characteristics outcomes and contribute to improving innovative capabilities (Di Maria et al., 2019; Laursen & Salter, 2006).

5.2.2. Hypotheses and Conceptual Model

To remain competitive, companies need to focus on their knowledge-based activities and possess specific skills that allow them to develop their potential innovation (Mendoza-Silva, 2021). According to Subramaniam & Youndt (2005), innovation can be incremental or radical. It is incremental when the ability of a company to improve products and services uses existing knowledge, technologies, and skills, or it is radical when the ability to generate significant transformation in existing products and services creates innovation that is new to the market. This research focused on two types of innovation: products and processes.

5.2.2.1. Innovative Activities and Knowledge Transfer (National Level)

Companies need the transfer of complementary knowledge from the network partners, as this process is conducive to improving innovative activities (Bellucci & Pennacchio, 2016; Laursen & Salter, 2006; Wang et al., 2020). Universities are critical in KT (Abbate et al., 2021; Bellucci & Pennacchio, 2016) because they complement companies' innovation activities (Medda, 2020). In this sense, companies, especially the most innovative ones, are aware that they will have to establish cooperation processes, particularly with universities, to acquire and develop more and better innovations (Cassiman & Veugelers, 2002). In response to the growing pressure felt by the market, companies introduce products, services, processes (Di Maria et al., 2019), and innovative organizational activities (Abbate et al., 2021).

Universities are considered external sources of knowledge. Thus, by establishing the U-I cooperation, companies will benefit from scientific and technological knowledge that will allow them to achieve innovation (Etzkowitz & Leydesdorff, 2000; Messeni Petruzzelli & Murgia, 2020). Indeed, universities have increased their involvement with industry in recent years to foster regional and national economic development and innovation systems (Etzkowitz & Leydesdorff, 2000). Some governments expect that universities contribute to innovation development in their regions (Atta-Owusu et al., 2021).

The U-I cooperation represents the universities' third mission (Etzkowitz & Leydesdorff, 2000). The effectiveness of the innovation process through the establishment of U-I cooperation depends on several factors, with geographic proximity being one of the most discussed (Ponds et al., 2010). Thus, companies' development and the effectiveness of their innovation activities depend on establishing cooperation, essentially with producers of local knowledge (Hasche, Höglund, & Linton, 2020). It is up to the universities to explore spatial proximity to transfer knowledge to meet the needs of companies (Di Maria et al., 2019). This cooperation can encompass different functional activities, such as R&D, marketing, components production, or information systems (De Bondt, 1997). Companies associated with innovative activities, particularly product innovation, tend to be more interested in cooperating with universities (López, Astray, Pazos, & Calvo, 2015). For Abbate et al. (2021), U-I cooperation with local universities represents a relevant source of knowledge but not for product innovation. According to Stojčić (2021), the KT obtained through the U-I cooperation from universities of the same country leads to an improvement in the company's innovative activities. Thus, the location of companies close to the universities is considered a strategic factor (Mascarenhas et al., 2022).

Thus, the first hypothesis is:

H1: National KT positively influences the development of innovative capacities of companies: a) Product; b) Process.

5.2.2.2. Innovative Activities and Knowledge Transfer (International Level)

For a long time, knowledge has been considered a critical resource to ensure the growth and survival of companies in an increasingly competitive market (De Bondt, 1997; Santoro & Saparito, 2006). According to Sherwood & Covin (2008), the knowledge of companies is obtained through internal learning processes and by external sources such as universities. This cooperation makes it possible to reduce the high and risky investments in new products and processes in the international context (De Bondt, 1997). U-I cooperation is crossing national borders, and it allows companies to develop their innovative capabilities (Jin et al., 2011). So, companies are motivated to cooperate to realize transfer knowledge (Santoro & Saparito, 2006), especially with universities, because it plays a crucial role in their innovation processes (Carlsson, 2006). However, geographic proximity can facilitate knowledge sharing and learning; it is neither a necessary nor sufficient condition to occur (Stojčić, 2021).

International U-I cooperation occurs when the countries' innovation systems are weak, and companies must research resources beyond borders (Stojčić, 2021). This type of cooperation consists of the globalization of science and technology, as the origin of knowledge and R&D activities take place in different countries (Jin et al., 2011). In this case, partners benefit from KT (Jin et al., 2011). The position of the various agents in the networks creates proximity between them, which promotes cooperation and the exchange of knowledge across boundaries (Messeni Petruzzelli & Murgia, 2020). Consequently, U-I international cooperation contributes to improving the capabilities and competitiveness of companies and improving the national innovation system of the country of origin (Jin et al., 2011).

Thus, the investigation hypothesis is:

H2: International KT positively influences the development of innovative capacities of companies: a) Product; b) Process.

5.2.2.3. Moderating role of Absorptive Capacity

Companies' knowledge to develop innovative activities, including R&D, generally depends on external sources that complement internal knowledge (Cassiman & Veugelers, 2002). According to Cohen & Levinthal (1990, p. 128), AC is "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends." This capacity varies according to the previous knowledge stock and capabilities to identify and assimilate knowledge flows of each company (Cohen & Levinthal, 1990). In this sense, AC improves the ability of companies to search and identify the relevant areas of information necessary to achieve innovation through external flows of knowledge (Escribano et al., 2009; Kostopoulos et al., 2011). For Escribano et al. (2009), AC is a source of competitive advantage that improves innovation performance. So, to innovate, companies must promote internal R&D efforts to generate new ideas and create know-how (Liu et al., 2005).

The KT process in developing U-I cooperation can be complex and even not created effectively. The company may have skills, cognitive structure, and culture that can hinder or prevent it (Perkmann et al., 2011). Thus, AC is a crucial element in this context to reduce barriers to knowledge exchange (Bruneel et al., 2010). Companies with high AC strategies will be more likely to capture the knowledge transmitted by universities (Bellucci & Pennacchio, 2016). U-I cooperation positively affects product innovation, and AC can be a moderating element according to the intended, incremental, or radical innovation (Kobarg et al., 2018). However, companies with enterprising and highly

qualified employees can lead to a business environment with a reluctance to incorporate external ideas, leading to lower business motivation to develop U-I cooperation (Kobarg et al., 2018).

The literature proposes several different AC measures. Cohen & Levinthal (1990) use R&D intensity; Cassiman & Veugelers (2002) use the presence of an internal R&D department; Kostopoulos et al. (2011) and Kobarg et al. (2018) operationalize the AC measure with in-house R&D, the existence of a complete R&D department, training and R&D skills. In this investigation, and following the different suggestions in the literature, AC is measured by in-house R&D, a continuously in-house R&D department, training and R&D skills, and the percentage of employees with higher education. Thus, the investigation hypothesis is:

H3: AC (internal R&D) positively moderates the relationship between National KT and the innovative capacities of companies: a) Product; b) Process.

H4: AC (internal R&D) positively moderates the relationship between International KT and the innovative capacities of companies: a) Product; b) Process.

H5: AC (continuity of internal R&D department) positively moderates the relationship between National KT and the innovative capacities of companies: a) Product; b) Process.

H6: AC (continuity of internal R&D department) positively moderates the relationship between International KT and the innovative capacities of companies: a) Product; b) Process.

H7: AC (training and R&D skills) positively moderates the relationship between National KT and the innovative capacities of companies: a) Product; b) Process.

H8: AC (training and R&D skills) positively moderates the relationship between International KT and the innovative capacities of companies: a) Product; b) Process.

H9: AC (employees with tertiary degree) negatively moderates the relationship between National KT and the innovative capacities of companies: a) Product; b) Process.

H10: AC (employees with tertiary degree) negatively moderates the relationship between International KT and the innovative capacities of companies: a) Product; b) Process.

5.2.2.5. Conceptual Model

This study aims to understand the impact of KT on the innovative capabilities of companies by making a comparative analysis of the influence of national and international KT. On the other hand, this research also analyses the moderating effect of absorptive capacity on the relationship between companies' KT and innovative capacity. Concerning the analysis of the data made available in the CIS, it was possible to identify two types of innovations that companies could develop: product and process.

According to OECD (2005), product innovation is related to developing or enhancing products, goods, or services by modifying their quality, appearance, functions, or technical specifications. Process innovation involves developing or improving a production or delivery method and the introduction of new task specifications, information flow, equipment, or software.

Figure 5.1 presents the conceptual framework.

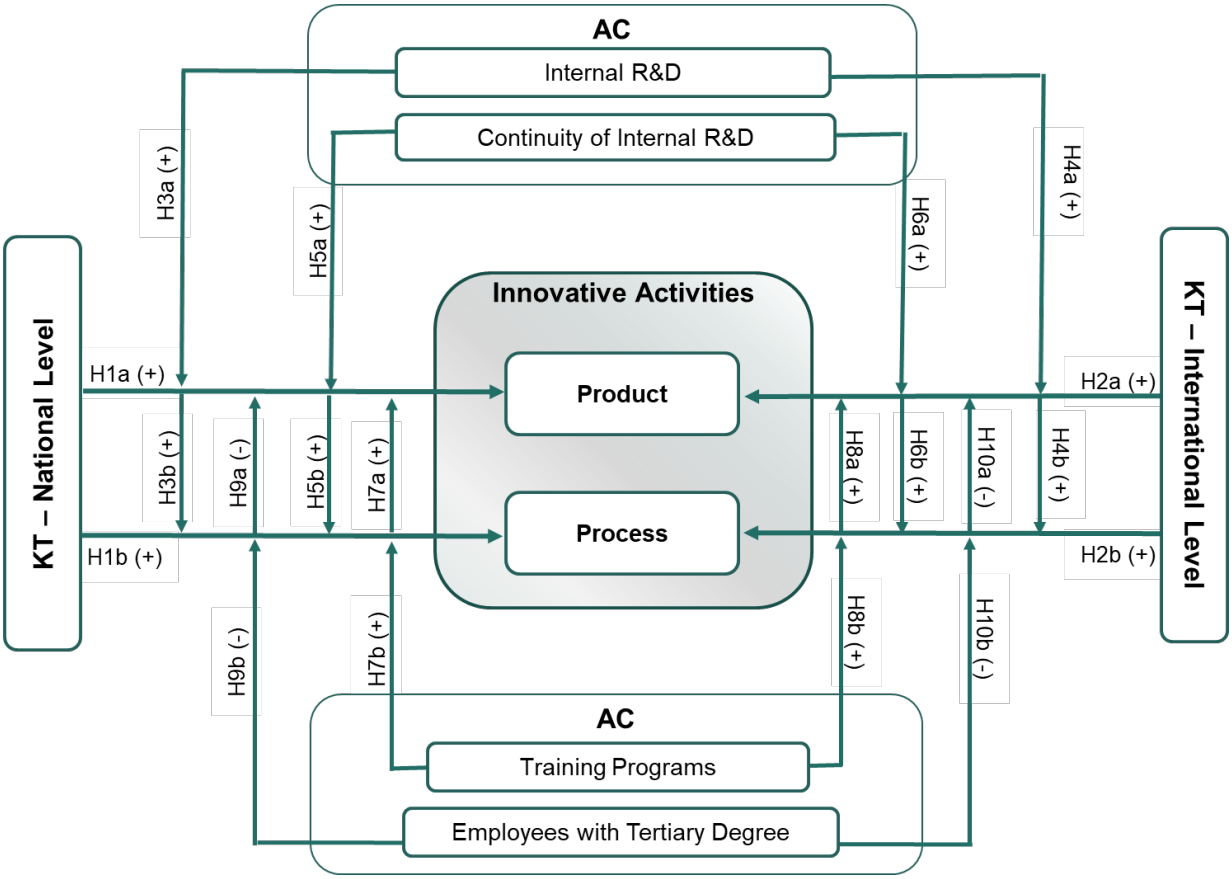


Figure 5.1 - Conceptual model of the effect of knowledge transfer in a company's innovation

5.3. Methodology

5.3.1. Data

This paper aims to measure the effects of KT – national and international – on companies' innovative capacities, in products and processes, and the moderating effect of AC on the relationship between companies' KT and innovative capacity. The empirical analysis was based on company-level data from the Community Innovation Survey (CIS) database, more specifically on the level of their innovation activities. Data are compiled and maintained by Eurostat and national statistical agencies in the respondent countries. The latest accessible version of the dataset covers the period 2012–2014, released in 2016. At the time of this writing, the dataset represents the most current source of information and the innovative behavior of companies in the EU Member States. Companies that did not develop any cooperation process of KT during this period were excluded, and 12808 observations were analyzed. The CIS database is commonly used in investigations of company innovation activities because it represents the most comprehensive source of information on these company activities in Europe (Iammarino, Piva, Vivarelli, & Von Tunzelmann, 2012; Laursen & Salter, 2006; Rõigas et al., 2018; Segarra-Blasco & Arauzo-Carod, 2008; Stojčić, 2021). The research's interpretability, reliability, and validity depend on extensive pre-tests and pilot tests across countries and sectors. The dataset is designed to encompass the systemic nature of innovation activities between firms and their external environment (Laursen & Salter, 2006). According to Iammarino, Piva, Vivarelli & Von Tunzelmann (2012), the CIS is the only database with information on different sources of innovation in EU countries, including cooperation between actors.

The questionnaire was implemented in 15 European countries, but only data from 14 of them were used. Cyprus data was not used because it did not include all the information necessary to estimate the conceptual model. The responses of companies belonging to the database in the period mentioned were analyzed, namely those from Germany (1456), Bulgaria (503), Croatia (309), Spain (4706), Estonia (291), Greece (623), Hungary (604), Latvia (121), Lithuania (549), Norway (1252), Portugal (891), Republic Czech (1011), Romania (204) and Slovakia (288), in a total of 12808 companies.

5.3.2. Variables

The CIS allows access to a series of objective and measurable variables that capture the general characteristics of companies. It also collects information about innovations developed by companies and shows the various partners with which they can cooperate and thus obtain the necessary knowledge to innovate. This study will analyze the effect of

KT obtained through cooperation with the universities or other higher education institutions of the same country (national) or another European country (international) in the innovation process. It also analyzed the moderating effect of AC on the relationship between companies' KT and innovative capacity. The dependent variable refers to the multiple types of innovation companies develop, namely product and process. The explanatory variables used are national or international KT that companies could obtain through U-I cooperation.

According to CIS, innovation introduces a new or significantly improved product or process method. The innovation could either be new to the market or new to the firm. Two variables were used, according to the available data. Regarding product innovation, it contains the analysis of several variables, namely a) goods innovations, b) services innovations; process innovations that include a) methods of manufacturing for producing goods or services, b) logistics, delivery, or distribution for inputs, goods, or services, c) activities for the processes, such as maintenance systems or operations for purchasing, accounting, or computing. The control variables are the size, sector of activity, and belonging or not to a business group.

Concerning the moderating variable AC, this research used a set of multiple measures, namely, internal R&D (ACI), the existence of a continuous R&D department (ACII), the presence of training and R&D skills (ACIII), and the employees holding a tertiary degree (ACIV).

The variables (dependents, explanatory, control, and moderators) considered to assess the hypotheses formulated are presented in Table 5.1.

Table 5.1 - Summary of variables used in the study

Name of variable	Variables Code	Description of Variable
Dependents Variables		
Product Innovation	INOV_PROD	1 = if the company introduced, new or significantly, products innovation(1) 0 = if the firm has not introduced any product innovation(1)
Process Innovation	INOV_PROC	1 = if the company introduced, new or significantly, process innovation(2) 0 = if the firm has not introduced any process innovation(2)
Explanatory Variables		
National Knowledge Transfer	KT_NAT	1 = if the company had access to knowledge transfer through cooperation with universities of the same country 0 = if the company did not have access to knowledge transfer through cooperation with universities of the same country
International Knowledge Transfer	KT_INT	1 = if the company had access to knowledge transfer through cooperation with universities of another EU country 0 = if the company did not have access to knowledge transfer through cooperation with universities of another EU country
Control Variables		
Size	SIZE	1 = if the number of employees of the firm varies between 10

		and 249 0 = if the number of employees of the firm is more than 249
Part of an enterprise group	GP	1 = if the company was part of an enterprise group 0 = if the company was not part of an enterprise group
Public Funds	FUND	1 = if the company has access to a least one public fund 0 = if the company has no access to a public fund
Moderator Variable Absorptive Capacity		
Internal R&D	ACI	1 = if the company had internal R&D 0 = if the company did not have internal R&D
Continuity of internal R&D department	ACII	0= the company has no staffed internal R&D department 1 = if the company has a continuously staffed internal R&D department 2 = if the company occasionally needs a staffed internal R&D department
Training and R&D skills	ACIII	1 = if the company had training activities for its staff 0 = if the company did not have training activities for its staff
Employees with a tertiary degree	ACIV	0 = if the company has up to 25% of employees with a tertiary degree 1 = if the company has more than 25% of employees with a tertiary degree

(1) The variable is 1 when one of the following innovations exists: good or services, and is 0 if it does not exist. The variable is 1 when one of the following innovations exists: methods of manufacturing for producing goods or services, or logistics, delivery, or distribution for inputs, goods, or services, or activities for the processes, such as maintenance systems or operations for purchasing, accounting, or computing, and is 0 if it does not exist.

5.3.3. Econometric Methods

The logistic regression method is used to predict the influence of independent variables on the dependent variable (Hair et al., 2014). A regression model was used since the dependent variable takes on a binary character, assuming a value equal to 1 if the company has new or significantly innovated and 0 if there was no innovation. The explanatory variables are also dichotomous, considering a value of 1 when the company had access to KT through U-I cooperation of the same country or from another EU country. On the other hand, the variable's value 0 exists when the company did not have KT through U-I cooperation of the same country or from another EU country. Finally, some control variables were introduced to reduce the impact of exogenous variables. The following model was contemplated to evaluate the established hypotheses, where getting access to KT – national or international - affects the type of innovation developed by companies:

$$P(Y_i = 1) = \frac{1}{1+e^{-f(x)}}, \quad (1)$$

Where,

$$f(x) = \beta_0 + \beta_1 KTj + \beta_2 SIZE + \beta_3 GP + \beta_4 \beta_5 FUNDS + \varepsilon$$

In the logistic regression equation (1), the value of P means the probability of innovation occurs; that is, the value of Yi is 1. Innovation refers to the dependent variables, in this

case, the product or process, and has the following variables: Y_1 – product innovation; Y_2 – process innovation. The explanatory variables refer to the KT to innovate, which can be obtained through cooperation established with universities, and have the following variables: J1 - KT_NAT when U-I cooperation is with universities of the same country or J2 - KT_INT when U-I cooperation is with universities from another EU country. The control variables are SIZE (number of employees), GP (belonging to a group), and FUND (public funds).

Then this research tests the moderating effect of AC in the relationship between companies' KT and innovative capacity. The analyses were performed using PROCESS macro (Hayes, 2013), and it was selected Model 1during the operation. The following model was contemplated to evaluate the established hypotheses:

Where,

$$f(x) = \beta_0 + \beta_1 KTj + \beta_2 ACk + \beta_3 KTj \times ACk + \beta_4 SIZE + \beta_5 GP + \beta_6 FUNDS + \varepsilon$$

In this case, AC refers to the moderated variable, and we have the following: k1 – internal R&D; K2 – a continuously internal R&D department; K3 – training and R&D skills; K4 – employees with a tertiary degree. So, in this moderated analysis, four effects have been explored in each scenario.

5.4. Results

Table 5.2 shows the frequencies of the explanatory and control variables. Regarding the different types of innovations that companies can develop, it is possible to verify that product innovation is the most common (69.1%), and 8527 companies developed process innovation (66.6%). Concerning the KT, it is possible to verify that companies obtained more innovations due to the U-I cooperation of the same country, with 4798 (37.5%) observations, compared to U-I cooperation with another EU country, with around 1087 (8.5%) observations. Finally, it is also possible to verify that the companies with less than 250 employees represent 75.2% of the observations, 57.2% are part of an enterprise group, and 52.8% of companies have access to at least one public fund.

In table 5.2, it is possible to conduct a more rigorous and detailed analysis of the various types of innovation studied. The innovation in products can be of two types: goods or services. Thus, 52.6% of the companies have introduced innovations in goods, and 33.7% have developed innovations in services. On the other hand, process innovation can be of three types: manufacturing methods, logistic systems, and support activities. In this case,

47.9% of companies have introduced innovative manufacturing methods, 40.7% introduced innovation in support activities, and 19.8% introduced innovations in logistic systems. Regarding the variables associated with absorption capacity, around 71.5% of companies develop internal R&D, and 38.3% have a permanent department related to R&D. On the other hand, 4972 companies, approximately 38.8%, offer training and R&D skills, and 5602 (43.7%) of the companies have more than 25% of employees with a tertiary degree.

Table 5.2 - Frequencies and percent of all variables

	Frequency	Percent
Prodcut Innovation	**8844**	**69.1**
• Good	6732	52.6
• Service	4320	33.7
Process Innovation	**8527**	**66.6**
• Methods and Manufacturing	6135	47.9
• Logistics systems	2538	19.8
• Support activities	5210	40.7
National Knowledge Transfer	**4798**	**37.5**
International Knowledge Transfer	**1087**	**8.5**
Size (until 249 employees)	9633	75.2
(more than 249 emplyees)	3175	24.8
Public Funds	6769	52.8
Part of an enterprise group	7323	57.2
Absportive Capacity		
• Internal R&D	9160	71.5
• Continuity of internal R&D department	4910	38.3
• Training and R&D skills	4972	38.8
• Employees with a tertiary degree	5602	43.7

N=12808

Logistic regression analyzes the relationship between the KT – national and international - and the innovative activities (see tables 5.3 and 5.4). The Omnibus Test of Models Coefficients ($p < .001$) value demonstrates that at least one of the explanatory variables, KT national or international KT, explains the innovation capacities of companies. So, is rejected the hypothesis that all coefficients are null. The -2 log-likelihood statistic value confirms the models' general significance compared to the null model.

As shown in Table 5.3, national KT has a positive and significant effect on the development of product ($\beta=0.49$; $p <.001$) or process innovation ($\beta=0.09$; $p <.001$), supporting hypotheses H1a and H1b. This research uses PROCESS macro to analyze the moderating effect of AC on the relationship between national KT and innovative activities. Thus, when the relationship is between national KT and product innovations, the results

are: internal R&D (β=0.25; z=2.40; p <.05), the continuity of an internal R&D department (β=0.64; z=7.17; p <.001), and training and R&D skills (β=0.17; z=1.84; p <.10), have a positive moderating effect on product innovations, thus confirming H3a, H5a, and H7a. On the other hand, having employees with a tertiary degree (β=-0.27; z=-3.23; p <.05) has a negative moderating effect, thus confirming H9a. Regarding the impact of the moderator AC on the relationship between national KT and process innovation, the results found were: the internal R&D (β=0.65; z=6.19; p <.001) and the continuity of an internal R&D department (β=0.83; z=9.77; p <.001), have a positive moderating effect on process innovations, supporting H3b and H5b. The moderating effect of training and skills R&D (β=-0.01; z=-0.07; *ns*) was not significant, and thus H7b was not confirmed. Finally, the variable having employees with a tertiary degree (β=-0.21; z=-2.67; p <.05) has a negative moderating effect, thus confirming H9b. Appendix A presents the values of the moderator variable's conditional effect.

Table 5.3 - Logistic regression - Effect of national knowledge transfer in the product and process innovation

	Products Innovation					Process Innovation				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.53 (0.04)***	0.33 (0.04)***	0.46 (0.04)***	0.24 (0.04)***	0.37 (0.04)***	0.66 (0.04)***	0.95 (0.05)***	0.74 (0.04)***	0.31 (0.04)***	0.69 (0.04)***
KT_NAT	0.49 (0.04)***	0.20 (0.09)**	0.19 (0.06)**	0.41 (0.05)***	0.57 (0.06)***	0.09 (0.04)**	-0.38 (0.09)***	-0.25 (0.06)***	0.04 (0.05)	0.22 (0.06)***
ACI		0.46 (0.05)***					-0.54 (0.05)***			
ACII			0.05 (0.05)					-0.56 (0.05)***		
ACIII				0.95 (0.05)***					1.21 (0.06)***	
ACIV					0.45 (0.05)***					-0.12 (0.05)**
Size	-0.19 (0.05)***	-0.21 (0.05)***	-0.23 (0.05)***	-0.21 (0.05)**	-0.11 (0.05)**	0.17 (0.05)***	0.18 (0.05)***	0.22 (0.05)***	0.17 (0.05)***	0.12 (0.05)**
GP	0.18 (0.04)***	0.15 (0.04)***	0.13 (0.04)***	0.14 (0.04)***	0.16 (0.04)***	0.11 (0.04)***	0.14 (0.04)***	0.13 (0.04)**	0.04 (0.04)	0.12 (0.04)**
FUNDS	0.09 (0.04)**	-0.05 (0.04)	0.07 (0.04)	0.10 (0.04)*	0.07 (0.04)*	-0.19 (0.04)***	-0.11 (0.04) **	-0.14 (0.04)***	-0.19 (0.04)***	-0.18 (0.04)***
KT_NAT x ACI		0.25 (0.10)**					0.65 (0.11)***			
KT_NAT x ACII(1)			0.64 (0.09)***					0.83 (0.08)***		
KT_NAT x ACIII				0.17 (0.09)*					-0.01 (0.09)	
KT_NAT x ACIV					-0.27 (0.08)**					-0.21 (0.08)**
Omnibus Tests of Models Coefficients	187.92***	321.26**	339.76***	769.01***	277.07***	59.94***	172.66***	248.13***	916.79***	92.63***
-2 Likelihood-ratio test	15660.58	15527.24	15508.73	15079.49	15571.43	16261.13	16148.41	16072.94	15404.29	16228.44

N=12808

***$p < 0.001$; **$p < 0.05$; *$p < 0.10$

(1) The results presented refer only to the category "Continuous internal R&D department" and the results of the category "Occasionally internal R&D department".

Table 5.4 reports the results obtained in the relationship between international KT and innovative activities – product and process and those obtained with the effect of the moderator variable AC. As shown in Table 5.4, international KT has a positive and significant effect on the development of product (β=0.77; p <.001) and process innovation (β=0.34; p <.001), supporting hypotheses H2a and H2b. Analyzing the moderating effect of AC on the relationship between international KT and product innovations, the results are that internal R&D (β=0.46; z=1.57; *ns*), training and R&D skills (β=0.08; z=0.45; *ns*), and having employees with a tertiary degree (β=-0.20; z=-1.18; *ns*) were no significant. Thus, it was impossible to confirm the hypotheses H4a, H8a, and H10a. On the other hand, continuity of an internal R&D department (β=0.45; z=2.59; p <.05) has a positive moderating effect on product innovations, confirming H6a. Concerning the effect of the moderator AC on the relationship between international KT and process innovation, the results are: internal R&D (β=0.14; z=0.43; *ns*) and training and R&D skills (β=-0.18; z=-1.17; *ns*) were not significant, and thus H4b and H8b were not confirmed. The variable continuity of an internal R&D department (β=0.76; z=5.05; p <.001) positively moderates process innovations, supporting H6b. Finally, the variable having employees with a tertiary degree (β=-0.28; z=-1.80; p <.10) has a negative moderating effect, confirming H10b. Appendix B presents the moderator variable's conditional effect values, and Figure 5.2 summarizes the hypotheses and findings.

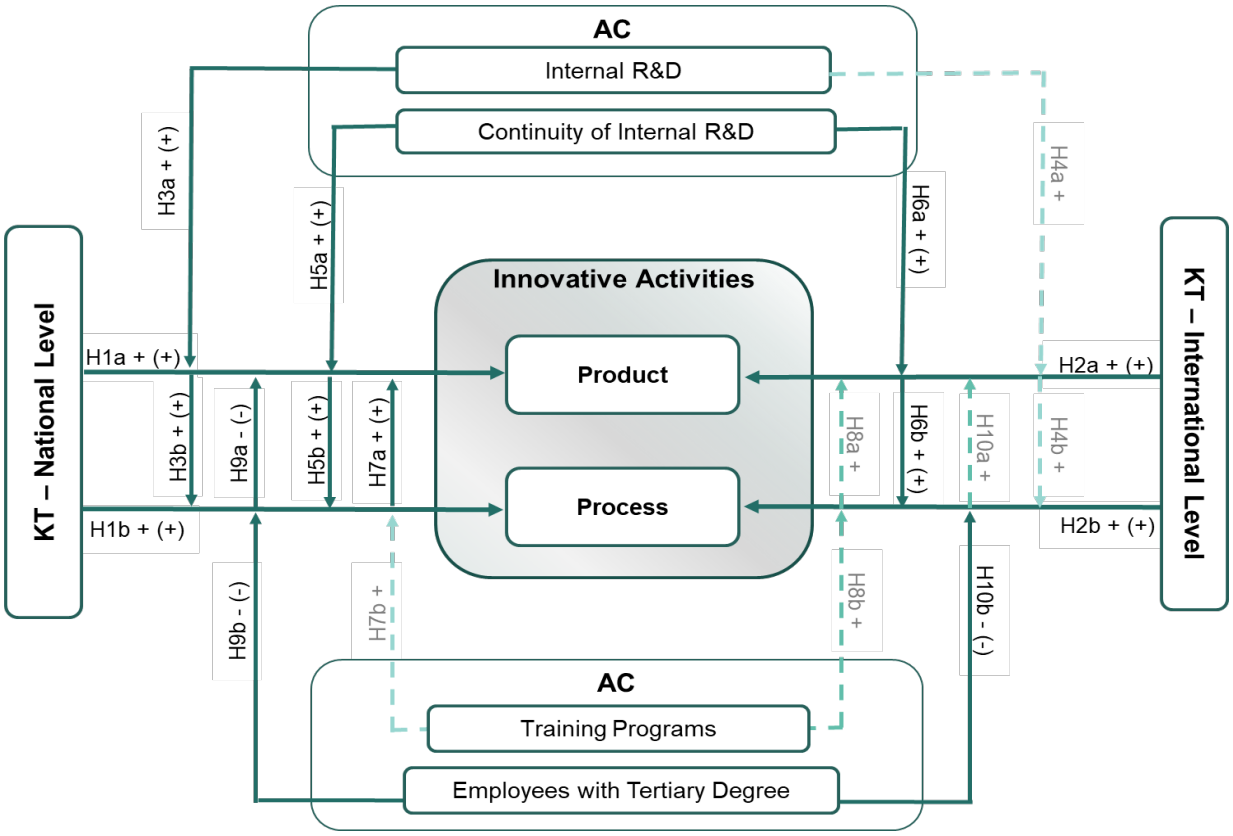
Table 5.4 - Logistic regression - Effect of international knowledge transfer in the product and process innovation

	Products Innovation					Process Innovation				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.62 (0.04)***	0.36 (0.04)***	0.48 (0.04)***	0.31 (0.04)***	0.48 (0.04)***	0.67 (0.04)***	0.87 (0.04)***	0.69 (0.04)***	0.31 (0.04)***	0.75 (0.04)***
KT_INT	0.77 (0.08)***	0.27 (0.28)	0.51 (0.13)***	0.69 (0.10)***	0.81 (0.13)***	0.34 (0.07)***	0.27 (0.32)	-0.12 (0.12)	0.33 (0.91)***	0.59 (0.13)***
ACI		0.54 (0.04)***					-0.39 (0.05)***			
ACII			0.28 (0.05)***					-0.28 (0.04)***		
ACIII				1.00 (0.05)***					1.22 (0.05)***	
ACIV					0.37 (0.04)***					-0.19 (0.04)***
Size	-0.19 (0.05)***	-0.21 (0.05)***	-0.25 (0.05)***	-0.20 (0.05)***	-0.11 (0.05)**	0.16 (0.05)**	0.17 (0.05)***	0.20 (0.05)***	0.16 (0.05)**	0.11 (0.05)**
GP	0.17 (0.04)***	0.14 (0.04)***	0.19 (0.04)***	0.12 (0.04)**	0.15 (0.04)***	0.11 (0.04)**	0.13 (0.04)**	0.12 (0.04)**	0.04 (0.04)	0.12 (0.04)**
FUNDS	0.15 (0.04)***	-0.01 (0.04)	0.11 (0.04)**	0.16 (0.004)***	0.13 (0.04)**	-0.20 (0.04)***	-0.09 (0.04)**	-0.13 (0.04)***	-0.21 (0.04)***	-0.19 (0.04)***
KT_INT x ACI		0.46 (0.29)					0.14 (0.33)			
KT_INT x ACII(1)			0.45 (0.17)**					0.76 (0.15)***		
KT_INT x ACIII				0.08 (0.18)					-0.18 (0.15)	
KT_INT x ACIV					-0.20 (0.17)					-0.28 (0.16)*
Omnibus Tests of Models Coefficients	149.62***	308.33***	262.44***	731.96***	231.89***	78.36***	151.80***	191.51***	930.30***	
-2 Likelihood-ratio test	15698.88	15440.17	15586.06	15116.54	15616.60	16242.71	16169.27	16129.56	15390.77	16209.73

N=12808

***$p < 0.001$; **$p < 0.05$; *$p < 0.10$

(1) The results presented refer only to the category "Continuous internal R&D department" and the results of the category "Occassionally internal R&D department".



Note: The figure shows the hypothesized direction of effect, the hypothesis designation, and the direction of the detected effect in the bracket.

——→ : Significant moderation effect
- - - - → : No moderation effect

+: Denotes a positive moderation effect
-: Denotes a negative moderation effect

Figure 5.2 - Hypotheses and results

5.5. Discussions and Implications

5.5.1. Discussions

Companies have limited resources to innovate. On the other hand, globalization and high market demands forced companies to cooperate with partners inside and outside the country, including universities. Thus, and despite the U-I cooperation allowing KT and consequently innovation, companies must develop their AC to manage external knowledge efficiently and effectively.

Despite the scientific studies developed based on this theme, there are current research calls for additional research on this topic (Kobarg et al., 2018; Van Wijk et al., 2008). Thus, based on Grant´s KBV (1996) using the Kobarg et al. (2018) method and the CIS 2016 database, this research aims to understand the influence of KT– national and international - on companies' innovative activities. It also analyses the moderating effect of AC on the relationship between companies' KT and innovative capacities.

This study confirms that national and international KT positively influence the innovative capabilities of companies, being a relevant source for the development of innovation in products and processes. This study demonstrates that AC is an important moderating variable when analyzing the relationship between national KT and innovation capacity - product and process. In detail, in the case of product innovation, the AC variables measured by internal R&D, the existence of a continuous R&D department, and R&D training and skills positively enhance the relationship between national KT and product innovation. On the contrary, the variable of having employees with tertiary degrees negatively potentiates that relationship.

In the case of process innovation, the AC variables measured by the internal R&D and the existence of a continuous R&D department positively moderate the relationship between national KT and process innovation. The variable of having employees with a tertiary degree negatively impacts the relationship between national KT and process innovation. However, the variable training and R&D skills is not significant in moderating the relationship between the influence of KT– National and Process Innovation. This not-significant relationship probably occurs because companies have already updated skills in R&D, and the development of training programs does not significantly potentiate the effect of innovation in the process.

There are different types of relationships regarding the influence of AC on the relationship between international KT and companies' innovative capacities. In detail, in the case of product innovation, the AC variable measured by internal R&D, training and R&D skills, and having employees with a tertiary degree has no significance in it. In contrast, the existence of a continuous R&D department positively enhances that relationship. In the case of process innovation, the variables of internal R&D and having employees with a tertiary degree do not significantly moderate the relationship between international universities' KT and process innovations. The no significant relationships probably occur because companies and universities are in different countries, which may cause difficulties in cooperation and respective KT due to differences in culture, language, and technologies. This scenario may cause constraints in sharing knowledge, R&D skills, and training. In turn, the variables of training programs and the existence of a continuous R&D positively moderate the relationship between international universities' KT and innovation in the process.

5.5.2. Implications

5.5.2.1. Theoretical Implications

This article provides a substantial number of theoretical contributions to the KT and innovation literature. First, it demonstrates that KT is crucial for companies' development in the global markets. U-I cooperation is essential for companies to develop innovative activities. From that perspective, this study reinforces that KBV theory is a crucial framework for managing companies, as they must have access to innovation to grow and compete in the market. This study contributes to the development of KBV theory information regarding the influence and importance of KT at a national and international level in the innovative activities of companies. It also contributes to it since previous studies mainly focus on innovation in products and the present work analyzes the innovative capacity of products and processes. This study also confirms the results of Grant (1996), who affirms that KT is vital for the companies, although to receive it, they have to cooperate. Thus, universities are essential and relevant partners for companies to access knowledge and innovation.

An analysis of the effect of KT - national and international - on companies was carried out, more specifically on their innovative capacities, through the study of U-I cooperation with universities of the same country or another EU country. The results demonstrate that national and international KT influence the innovative activities developed by companies confirming the results obtained by Stojčić (2021), Carlsson (2006) and Jin et al. (2011). However, they contradict the work of Abbate et al. (2021), which states that the national KT does not influence product innovation. This difference exists probably because Abbate et al. (2021) analyzed a specific sector of activity, the wine industry, and the present work uses a large sample of European companies from 14 countries.

On the other hand, this research expands the literature on the moderating effects of AC on the relationship between KT and the innovative capacities of companies. In addition, it complements previous studies like those of Eom & Lee (2010) and Kobarg et al. (2018) by analyzing innovative activities in the CIS, namely, product and process. Regarding the effect of AC on the relationship between national KT and innovative capacities, it was possible to verify that the variable related to internal R&D and the continuity of the internal R&D department has a positive and moderating effect on product and process innovations. These results corroborate the statement of different studies (see: Escribano et al., 2009; Kostopoulos et al., 2011; Liu et al., 2005) that

companies should acquire external knowledge to complement their internal R&D activities to innovate. Also, the results demonstrate that training and R&D skills have a moderating effect on the relation between national KT and innovative capacity on product innovation. Thus, it is possible to conclude that companies should provide more training offered by universities to allow product innovation (Kobarg et al., 2018). Finally, the moderating effect of AC measured by employee degree negatively affects the relation between national KT and product and process innovations. These confirm the results of Cohen & Levinthal (1990), which state that if universities perceive that partner's absorption capacity is very high, it may cause secrecy and barriers to developing cooperation and the KT.

Concerning the moderating effect of AC on the relationship between international KT and innovative capacities, it was possible to verify that the variable related to internal R&D and training and R&D skills does not significantly affect the relationship between international KT and innovation activities - products and process. Differences in culture and knowledge between companies and universities from another EU countries may cause barriers to the capacity to absorb external knowledge, whether R&D or training, which confirms the results of Perkmann et al. (2011). According to Kobarg et al. (2018), this result is also justified if the company's innovation intends to develop was incremental. About the moderating effect of AC measured by the continuity of the internal R&D department, there is a positive and moderating effect on product and process innovations. Finally, it is not significant the moderating effect of AC measured by the employee degree in the relationship between international KT and product innovations. This result confirms the work developed by (Kobarg et al., 2018). However, that moderating effect is negative in the generation of process innovation.

Therefore, this study develops the KBV theory identifying the influence of national and international KT on the innovative capacities of companies. Specifically, this research uses a European U-I database of 14 countries and incorporates both innovations in processes and products, when before it was usually in products. It also responds to literature calls from Franco et al. (2014) and Mohnen & Hoareau (2003) to further research on the effect of KT on innovation that results from U-I cooperation.

5.5.2.2. Managerial Implications

The need to survive in an increasingly competitive market forces companies to be innovators. So, they must cooperate with universities since they are considered a source of knowledge. This study analyzes the effects of KT, national and international, on the innovative capacities of companies, through U-I cooperation of the same country or

another EU country. This research also analyses the moderating effect of AC on the relationship between companies' KT and innovative capacity.

In practical terms, this research improves the knowledge of KT benefits in companies' innovative capabilities. On the other hand, it also provides insights into the AC of companies, more specifically about internal factors that may serve as moderators in the relationship between KT and innovation. Thus, managers must develop strategies that allow the capture of knowledge from universities since this influences the development of innovations in products and processes. When KT is from universities of the same country, managers should invest more in internal R&D activities, create a continuous R&D department, and have employees with a tertiary degree. Those measures increase the company's absorption capacity and permit to improve the benefits of obtaining external sources of knowledge. On the other hand, when KT provides by universities of another EU country, managers should invest in creating a continuous R&D department and have more employees with a tertiary degree to potentiate the process innovation that occurs as a consequence of U-I KT.

Thus, managers will need to develop strategies to overcome possible barriers to developing U-I cooperation. Therefore, since KT- national and international - influences the innovative capacity of companies, they must develop strategies that allow and encourage U-I cooperation with universities of the same country or another EU country.

In addition, it was possible to verify that universities transfer knowledge to companies to innovate. Universities must disclose their work and research to companies so that the market knows what exists and what their capabilities are. Universities must become aware of their entrepreneurial role in society and create strategies that support U-I cooperation. However, to solve companies' problems, the universities must be focused on them. For more proximity and concern with the market's needs, universities must develop internal policies that may include the attribution of rewards to the researchers involved in the process. Thus, universities and industries still have a long way to increase U-I partnerships.

This research showed that the geographic proximity between the cooperation agents influences the KT and, consequently, the innovative activities. Thus, governments play a crucial role in the innovation processes, namely through their impact on U-I cooperation. Public policies must allow for the improvement and strengthening of U-I cooperation. Governments should support and encourage universities to carry out more research. On the other hand, public support and funds must also facilitate U-I

cooperation and KT. Thus, policy measures should develop and allocate incentives for industry and researchers. National and international policies must motivate national and international cooperation, allowing KT and their respective innovation.

5.6. Conclusions, limitations, and future research directions

This study attempts to understand the effects of KT on the innovative capacities of the companies. This research intended to compare the KT that companies obtained national or internationally. It analyzed the U-I cooperation developed with universities in the same country and with another EU country. This research also analyses the moderating effect of AC on the relationship between companies' KT and innovative capacity.

The U-I cooperation allows the combination of the companies' market-based experience and the scientific knowledge of universities that can significantly favor the creation of innovations (Etzkowitz & Leydesdorff, 2000). This research concluded that national and international KT is significant for companies to develop innovative activities in products and processes. Although the proximity factor can be beneficial, it will not be fundamental for companies to innovate and achieve competitive advantages. On the other hand, the results of this research show that AC should be regarded as a moderating variable when cooperation is with national universities, as it impacts the relationship between KT and innovative activities - product and process. The same is not noticeable in cooperation with a university in another EU country, as AC does not significantly affect most of the variables used to measure it, essentially when the same occurs in product.

Finally, this research demonstrates that university knowledge positively affects companies' innovative activities. This is in line with the studies carried out by Mohnen & Hoareau (2003), Tether (2002), Abbate et al. (2021), Fernández López et al. (2015), and Messeni Petruzzelli & Murgia(2020). This analysis is essential to understand the importance of KT, specifically national and international, in the innovative capacities that companies developed. Thus, it will be easier for companies to know with whom they should cooperate in obtaining complementary knowledge to innovate.

However, the data obtained from the CIS database is a limitation to the development of this research. Only technologically innovative companies respond to CIS concerning

their cooperation partners. Thus, this research uses a sample biased towards technologically innovative companies. So, it is necessary to develop studies related to U-I cooperation that analyze different activity sectors in technologically innovative companies. On the other hand, it is impossible to know which type of university the companies cooperated with, public or private. Thus, future research can verify the differences between U-I cooperation and universities, public or private, and whether the companies obtain more KT and, therefore, more innovative activities. Another suggestion is the development of an individual country analysis to compare with the data obtained. Finally, to better understand each country reality, it was necessary the development of more studies with primary data (qualitative and quantitative).

Part III

Chapter 6. Final Considerations

6.1. Conclusions

This chapter presents the main conclusions of the thesis. It also exposes considerations at the theoretical and practical levels, namely for managers, universities, and governments. Finally, the chapter presents some study limitations and future investigation lines.

To remain in the market and be competitive, companies need to innovate. One means used is their cooperation with other agents, specifically universities. U-I cooperation has been a significant area of interest for companies and governments as it allows for the development and growth of companies and countries. However, despite the numerous studies in this area, much remains explored.

The thesis includes four studies to answer the research questions proposed in this investigation.

1. What aspects and categorization of U-I cooperation literature have been studied over the last few years?

An SLR entitled “Cooperation University-Industry: A Systematic Literature Review” was developed to answer the first research questions. Thus, in chapter 2, a literature survey was carried out to contribute to the literature state of the art. Through bibliometric analysis, it was possible to identify four clusters: 1) Triple Helix, 2) Knowledge Transfer, 3) Determinants of Cooperation, and 4) Strategic Alliances. Recognizing these 4 clusters allows for a global analysis of the U-I cooperation process. Thus, it is possible to verify the importance of analyzing the determining factors for the development of U-I cooperation. Another aspect is related to the government's importance, namely through its policies, measures, and funds that can effectively support the U-I cooperation. Finally, identify what U-I cooperation influences KT to develop new innovative capabilities for companies.

Despite having identified these 4 clusters, the results obtained conclude that exists a strong connection between the TH and Strategic Alliances clusters. It was possible to verify that the U-I cooperation is a process that companies, universities, and governments want and should develop because everyone is aware of its benefits. However, it is imperative to study U-I cooperation and its driving factors to eliminate

barriers. On the other hand, the government, mainly through the TH model, has a fundamental role in U-I cooperation insofar as the measures taken by the government have a leading and impacting role in the success of U-I cooperation, in the development of companies and countries. From this, we can infer that U-I cooperation is an area that still has much to be studied.

2. What is the role of government (public funds) in creating knowledge?

To innovate, companies must cooperate with other agents, such as customers, suppliers, competitors, and universities (Badillo et al., 2017). However, for cooperation to benefit all parties involved, government intervention are central, whether through policies, measures, or allocation of public funds. To answer the second research question, a study was developed that intends to investigate the role of the government in the cooperation that companies establish with the various agents that make up the TH, that is, university, industry, and government.

The research "Triple Helix Model – Cooperation in Knowledge Creation" confirms the influence that the government plays in the cooperation that companies establish with the various agents of TH, more specifically through the allocation of public funds. For a more detailed and comprehensive analysis, a study was carried out with the different cooperation established between companies and the various agents of TH, companies, universities, and governments. The research analyses the relationship between companies and agents in the same country and another EU country. The study confirms and demonstrates that all public funds analyzed – local/regional, central government, or EU – have a significant impact on the process of cooperation with all TH agents. However, not all have the same effects. The central government fund is the one that most influences the cooperation of companies with any of the TH agents when they are in the same country. In contrast, EU funds affect the cooperation established with companies, HEIs, and governments of another EU country.

3. What factors influence U-I cooperation?

U-I cooperation allows companies to have access to resources and knowledge that, in general, they do not have, allowing them to achieve innovation and competitive advantages (Jones & Corral de Zubielqui, 2017; Rõigas et al., 2018). However, not all companies cooperate because they do not have the necessary determinants. A study was developed to identify the determining factors in establishing U-I cooperation to

answer the third research question. The analysis considers U-I cooperation with universities in the same country, in another EU country, or in a country outside the EU.

The study entitled “Determining Factors For U-I Cooperation: a European Study” confirms that the company's size, the innovative capabilities associated with R&D, exports, and public funds are essential determinants for the establishment of cooperation, regardless of the location of the university. On the other hand, the acquisition of machinery and training programs are not a critical factor in establishing collaboration with universities outside the EU.

4. What is the effect of knowledge transfer on the innovative capacity of companies?

Obtaining knowledge from external sources will allow companies to improve their innovative capabilities (Bellucci & Pennacchio, 2016). Thus, business success, combined with innovation, will depend on the internal resources of companies and the external sources of knowledge used, namely U-I cooperation (Figueiredo & Fernandes, 2020; Medda, 2020; Wang et al., 2020). This study aims to answer the fourth research question investigating the effect of KT at the national and international level on companies' innovative capacity - product and process. The study “The moderating effect of absorptive capacity on the relationship between knowledge transfer and innovative capacity” confirms that the KT obtained through U-I cooperation effectively impacts the innovative activities of companies, both in terms of products and processes. These results are verified for the national and international KT.

5. What is the moderating effect of absorptive capacity in the relationship between KT and innovation?

The knowledge of companies to develop innovative activities depends on external sources that complement internal knowledge (Cassiman & Veugelers, 2002). However, only through a high AC company will it be able to search and identify the relevant areas of information needed to achieve the innovation obtained through U-I cooperation (Escribano et al., 2009; Kostopoulos et al., 2011). The study “The moderating effect of absorptive capacity on the relationship between knowledge transfer and innovative capacity” answers the fifth research question investigating the moderating effect of AC between KT and innovative capacity. Regarding the influence of AC on the relationship between national KT and product innovation, the AC variables measured by internal R&D, the existence of a continuous R&D department, and R&D training and skills positively enhance the relationship. On the contrary, the variable of having employees

with tertiary degrees negatively potentiates that relationship. Regarding the influence of AC on the relationship between national KT and process innovation, the AC variables measured by the internal R&D and the existence of a continuous R&D department positively moderate this relationship; the variable of having employees with a tertiary degree negatively impacts the relationship; the variable training and R&D skills is not significant in moderating the relationship.

Concerning the influence of AC on the relationship between international KT and product innovation, the AC variable measured by internal R&D, training and R&D skills, and having employees with a tertiary degree has no significance in it. In contrast, the existence of a continuous R&D department positively enhances that relationship. In the case of the influence of AC in the relationship between international KT and process innovation, the variables of internal R&D and having employees with a tertiary degree do not significantly moderate the relationship. In turn, the variables of training programs and the existence of a continuous R&D positively moderate this relationship.

6.2. Main implications

This thesis provides implications for theory and practice, which can contribute to the development of both society and the scientific world.

The study of chapter 2 contributed to the literature, highlighting the most relevant areas of U-I cooperation and systematizing the main investigations carried out in the area, thus allowing a deepening of the theme. Therefore, using the SLR method and bibliometric techniques, a mapping was made of the most investigated areas of the theme. On the other hand, it allowed to point out current and future trends regarding U-I cooperation, thus contributing to new lines of investigation. This SLR also presents contributions to practice, as this topic has generated significant interest on the part of governments, industry, and universities. It allows the deepening of knowledge about other determining factors for U-I cooperation, identifying different types of partnerships, and achieving results that may arise from this cooperation.

The study of chapter 3 made it possible to deepen knowledge about the importance of governments, namely through public funds, in the cooperation that companies establish with the various agents of TH, namely companies, universities, and government. At a theoretical level, this study reinforced the importance of the government in establishing the cooperation process. On the other hand, it made it

possible to reinforce TC by analyzing the significance of TH as an essential framework for business innovation. This research also has practical implications, serving as guidelines for all TH agents interested in cooperating by generating KT and innovation, thus leading to the development of companies and countries.

The study of chapter 4 made it possible to reinforce the TRC by confirming that cooperation is essential for obtaining resources and knowledge, as companies do not always own them. However, not all companies have the determining factors for establishing U-I cooperation. The size of the companies, the innovation activities, the exportation, and the government resources are factors considered decisive for developing U-I cooperation with national and foreign universities. Regarding the practical implications, this study allowed to characterize the companies most prone to develop U-I cooperation. On the other hand, it makes it possible to provide suggestions for universities and for government improve policies that could promote U-I cooperation.

The study in chapter 5 reinforced the existing literature, contributing to a better understanding of the importance of KT, national and international, and its influence on the innovative capacity of companies, products, and processes. Thus, it contributes to the development of the KBV theory, as it reinforces the importance of companies accessing KT through U-I cooperation to develop innovation and therefore grow and compete in the global market. On the other hand, this research expands the literature on the moderating effects of AC on the relationship between KT and the innovative capacities of companies. In practical terms, it confirms the importance of U-I cooperation in KT and the companies' innovation capacity. On the other hand, it demonstrates that if companies have a high degree of AC, mainly associated with R&D, this will have a significant moderating effect on the relationship between KT and innovative capabilities. Finally, it also suggests action measures for companies, governments, and universities.

6.3. Limitations and future lines of investigation

This thesis has limitations that are pertinent for the development of future investigations. Chapter 2 uses a single database to collect the relevant literature (WoS) to develop the research . Although many authors consider it the most complete, some relevant studies may have been excluded from the analysis. Regarding the limitation associated with chapters 3, 4, and 5, they are built with the CIS database. Thus,

although it contains extensive information about companies from 15 EU countries, it was only possible to analyze 14, since the database did not include the data from Cyprus relevant for the development of those studies. On the other hand, only technologically innovative companies respond to CIS concerning their cooperation partners.

Hence, table 6.1 sets out the contextual and methodological orientations for U-I cooperation research and the shortcomings in future research's indicative knowledge and insights.

Table 6.1 - Contextual and methodological orientations and future research directions for U-I cooperation

Theory	• Which theories hold the greatest relevance to the study of cooperation U-I? • Should new theories be developed? • How can existing theories be developed and enriched to explain U-I cooperation practices better? • Which cooperation U-I theory holds the potential in terms of conceptual contributions to develop a broader reaching literature? • How might we interrelate the structure, the organization, and the U-I cooperation?
Context	• What are the similarities and differences in the various U-I approaches? • What are the similarities and differences in U-I cooperation according to company strategies? • What factors explain these differences? • What importance do informal relationships hold to the success or non-success of U-I cooperation? • What are institutional pressures at stake? Within the same sector, what configurations change from company to company? Across different sectors, what similarities are there in company organizations?
Content	• What role are resources and capacities in defining U-I cooperation practices? • Which factors measure the U-I cooperation relationship – with what results at the institutional, organizational, and individual levels? • How does institutional logics interrelate with U-I cooperation? • Why do some business leaders attribute more / less importance to U-I cooperation?
Method	• How are we able to significantly measure U-I cooperation? • How might we measure the impact of the utilization or otherwise of U-I cooperation in a company? Are these distinctive or similar metrics? • Do the different levels of U-I cooperation require different methodologies? • How might we combine various methods to explore U-I cooperation based on the different levels of analysis? • How might we develop large-scale databases for measuring U-I cooperation performance? • Do researchers need to modify the underlying assumptions of the methodologies applied to studying U-I cooperation?

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Appendix

Appendix A

1.I. Moderation Effect of ACI in the relationship of National KT and Innovation in Product

Conditional effects of the focal predictor at values of the moderator(s):

rrdin	Effect	se	Z	p	LLCI	ULCI
,0000	,2008	,0931	2,1576	,0310	,0184	,3833
1,0000	,4520	,0492	9,1823	,0000	,3555	,5485

1.II. Moderation Effect of ACII in the relationship of National KT and Innovation in Product

Conditional effects of the focal predictor at values of the moderator(s):

rdeng	Effect	se	Z	p	LLCI	ULCI
,0000	,1991	,0621	3,2081	,0013	,0775	,3207
1,0000	,8420	,0664	12,6769	,0000	,7118	,9721
2,0000	-,0621	,1250	-,4969	,6193	-,3072	,1829

1.III. Moderation Effect of ACIII in the relationship of National KT and Innovation in Product

Conditional effects of the focal predictor at values of the moderator(s):

rtr	Effect	se	Z	p	LLCI	ULCI
,0000	,4114	,0510	8,0656	,0000	,3114	,5114
1,0000	,5836	,0802	7,2724	,0000	,4263	,7409

1.IV. Moderation Effect of ACIV in the relationship of National KT and Innovation in Product

Conditional effects of the focal predictor at values of the moderator(s):

empud_dd	Effect	se	Z	p	LLCI	ULCI
,0000	,5686	,0570	9,9746	,0000	,4569	,6803
1,0000	,2987	,0635	4,7014	,0000	,1742	,4232

2.I. Moderation Effect of ACI in the relationship of National KT and Innovation in Process

Conditional effects of the focal predictor at values of the moderator(s):

rrdin	Effect	se	Z	p	LLCI	ULCI
,0000	-,3783	,0959	-3,9457	,0001	-,5662	-,1904
1,0000	,2758	,0453	6,0856	,0000	,1870	,3647

2.II. Moderation Effect of ACII in the relationship of National KT and Innovation in Process

Conditional effects of the focal predictor at values of the moderator(s):

rdeng	Effect	se	Z	p	LLCI	ULCI
,0000	-,2475	,0610	-4,0599	,0000	-,3670	-,1280
1,0000	,5813	,0608	9,5670	,0000	,4622	,7004
2,0000	-,1801	,1216	-1,4816	,1385	-,4184	,0582

2.III. Moderation Effect of ACIV in the relationship of National KT and Innovation in Process

Conditional effects of the focal predictor at values of the moderator(s):

empud_dd	Effect	se	Z	p	LLCI	ULCI
,0000	,2216	,0566	3,9157	,0001	,1107	,3326
1,0000	,0115	,0574	,2009	,8408	-,1009	,1240

Appendix B

1.I. Moderation Effect of ACII in the relationship of International KT and Innovation in Product

Conditional effects of the focal predictor at values of the moderator(s):

rdeng	Effect	se	Z	p	LLCI	ULCI
,0000	,5056	,1279	3,9532	,0001	,2549	,7563
1,0000	,9558	,1196	7,9924	,0000	,7214	1,1902
2,0000	,6233	,2963	2,1038	,0354	,0426	1,2039

2.I. Moderation Effect of ACII in the relationship of International KT and Innovation in Process

Conditional effects of the focal predictor at values of the moderator(s):

rdeng	Effect	se	Z	p	LLCI	ULCI
,0000	-,1150	,1161	-,9908	,3218	-,3425	,1125
1,0000	,6429	,0968	6,6446	,0000	,4532	,8325
2,0000	,8075	,3049	2,6482	,0081	,2099	1,4052

2.II. Moderation Effect of ACIV in the relationship of International KT and Innovation in Process

Conditional effects of the focal predictor at values of the moderator(s):

empud_dd	Effect	se	Z	p	LLCI	ULCI
,0000	,5887	,1312	4,4881	,0000	,3316	,8458
1,0000	,3068	,0871	3,5223	,0004	,1361	,4776