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More than meets the partner: a systematic review and agenda for University–Industry cooperation

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Abstract
The literature on university–industry relations suggests the need for greater clarification and deeper systematization of the University–Industry cooperation process. This study aims, using a systematic review of the literature to deepen the University–Industry *state of the art* and identify the main research trends. ISI's *Web of Science* was the database used, and a *Bibliographic Coupling bibliometric analysis* was performed. Based on the outcomes of the literature review, we could identify four *clusters*: (1) motivations and barriers to cooperation, (2) determinant factors, (3) government measures, and (4) Intersector technological cooperation. This article reveals that industries are willing and motivated to engage in cooperation agreements with universities due to knowledge and technology transfer, however, some barriers will have to be overcome. Based on the existing literature, an agenda for further research was laid out.

Keywords University–industry · Cooperation · Systematic literature review · Knowledge transfer

JEL Classification L1 · L2 · M1 · M2 · O3

1 Introduction

In a global age and of knowledge-based economies, companies are forced to engage in partnerships to expand their horizons and thus achieve the knowledge they need to innovate (Gallego et al. 2013; Fernández-López et al. 2019).

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The extensive use of the terms cooperation and networking is due to fashion, but also reflects a recognition that technological innovations are less and less the outcome of individual efforts (Fischer and Varga 2002). If companies give due credit to cooperation and information provided publicly by universities, they tend to be more able to increase the productivity of their innovation activities (Badillo and Moreno 2016).

The use of *spillover* knowledge will result in positive outcomes and should be seen as a key-factor in cooperation agreements (Veugelers and Cassiman 2005; Szücs 2018) whether we are talking about outgoing or incoming spillovers. Incoming spillovers are external knowledge flows that a firm can capture, and their information source is public, whereas outgoing spillovers refer to the company's ability to control knowledge flowing across its limits (Badillo et al. 2017).

The companies' intensity in developing internal R&D activities, lead to a greater propensity for cooperation. Thus, well-structured companies developed in R&D become possible cooperation partners (Gallego et al. 2013; Fernández-López et al. 2019).

Companies seeking cooperation liaisons that will allow them to exploit external sources of knowledge want to intend to exploit various synergies such as costs, capital alliances (Fageda et al. 2019), the development of platforms or product components (Bourreau et al. 2016), access to the latest technological knowledge or new markets, to benefit from economies of scale in joint R&D and/or production, to share risks (Fischer and Varga 2002) and to achieve greater levels of both product and process innovation (Stejskal et al. 2016), the creation of R&D projects and other projects involving consulting and technical assistance, the diffusion of technology, and the promotion of international cooperation (Badillo et al. 2017), or to patent counting and R&D innovation (Szücs 2018). To absorb the external knowledge offered by other agents, firms need an internal knowledge base and develop internal R&D (Veugelers and Cassiman 2005).

Cooperation can involve different types of partners, namely customers, suppliers, competitors, other firms that belong to the same company group, universities, and research institutes. This diversity can be particularly beneficial since the different firms will be able to acquire complementary knowledge or skills (Iammarino et al. 2012; Badillo and Moreno 2016).

Lhuillery and Pfister (2009) divide cooperation partners into three groups: competitors, public research organizations, and foreign partners. Cooperation with universities should not be analysed in isolation from the overall innovation strategy of the firm, instead, it should be perceived as a complementary component of its internal R&D development capacity and of its search for public information that will increase its ability to obtain and absorb external knowledge (Veugelers and Cassiman 2005). Another form of cooperation that combines R&D and intersector technologies is the so-called Intersector Technology Cooperation (ITC), which is established, especially between industry and university and R&D laboratories (Geisler 2001). This cooperation is a complex phenomenon whose success depends on a combined effect of individual and organizational variables in both parties involved (Geisler and Turchetti 2015). The selection of the right partners by considering external environment can bring success

to focal firms in R&D cooperation (Seo et al. 2017). According to Veugelers and Cassiman (2005) collaboration between a firm and research institutions or universities involves less sensitive matters as compared to the more commercially content when cooperating with a fortiori competitor because information can be more easily shared.

Those who can manage or oversee the cooperation process are challenged with the task of understanding how the whole cooperation phenomenon works and of maximizing the results achieved from the investment (Galan-Muros and Davey 2019). According to Chen et al. (2016), there are many forms of cooperation between University–Industry (U–I), namely direct contact between U–I, government-led cooperation initiatives, or even R&D transfer through social institutions and university cooperation platforms.

Despite the growing cooperation between U–I, this interaction has not yet reached its true potential. It is then necessary to introduce resources, for example through different incentives provided by governments that will help overcome the barriers that still hamper such relationship (Alves et al. 2015).

U–I cooperation has attracted the attention of the governments countries because it enables economic development (Chen et al. 2016), and the development of a wide range of organizations (Fischer and Varga 2002). Although many are skeptical when they look at the role played by governments, truth is they play a key role in U–I cooperation, namely when they are asked to fund R&D projects (Suh et al. 20192016) or to encourage and implement sharing of ideas (like the intellectual property protection mechanism) among the different innovation actors (firms, suppliers, universities, competitors) (Seo et al. 2017). The government policies play a crucial role in promoting U–I collaboration, namely through public funds used to encourage research and private development (Badillo et al. 2017).

The Triple Helix cooperation, i.e. University–Industry–Government (U–I–G), is crucial for the firms' economic progress and strategic superiority, as universities are not just the inventors of new technologies, but are also the suppliers of specialized and qualified employees and the mediators between economy and society (Chen et al. 2016). Thus, there is a strong need for a government structure that will be capable of promoting the implementation of cooperation goals between U–I, solving problems and establishing clear rules for all stakeholders (Alves et al. 2015).

There is a vast literature on the topic cooperation U–I. Some studies have already carried out systematic literature review (SLR) focused on U–I Cooperation, such as Sjöö and Hellström (2019) that analysed the factors stimulating collaborative innovation, Mendoza and Sanchez (2018) analyzed the relationship between models, agents and mechanisms as influencing factors in technology transfer or Mascarenhas et al. (2018) analyzed university entrepreneurship, and open innovation.

Mascarenhas et al. (2018), suggest the elaboration of studies that allow to increase the knowledge of the downstream and upstream aspects of U–I cooperation. Thus, this investigation intends to contribute to this literature GAP, making this systematization through the use of bibliometric techniques. This SLR aims to illustrate the state-of-the-art and systematize the main research trends regarding U–I cooperation.

According to the objective of this study, the research question will be to analyze which are the main thematic areas related to U–I cooperation.

A rigorous research protocol was followed to prepare this systematic review of the literature (Tranfield et al. 2003). The search for articles was carried out in the Web of Science database (Gasparyan et al. 2013a, b). The defined research protocol led to the inclusion of 64 articles in the investigation, which were subsequently submitted to a bibliometric analysis—bibliographic coupling to obtain a similarity relationship between the articles grouping them by clusters.

The results allowed us to identify four different *clusters:* (1) motivations and barriers to cooperation, (2) determinant factors, (3) government measures and (4) intersector technology cooperation.

Not only will this review of the U–I cooperation enrich the existing literature, but the framework it puts forward will also contribute to a deeper perception of the U–I cooperation process. The article also presents a research agenda.

The article is organized as follows. Section 2 describes the methodology used and the database used in the research study. Section 3 presents the outcomes. Section 4 stresses the future lines of research and, finally, Sect. 5 presents the conclusions of the research study.

2 Methodology

This study was based on a SLR of the literature where it is intended to organize, evaluate and synthesize literature, identifying patterns, trends and gaps in future research (Tranfield et al. 2003a, b; Gough et al. 2012), based on the topic was cooperation between universities and industry. According to Tranfield et al. (2003) SLR should be developed based on a rigorous research protocol for minimizing the bias.

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

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

In the first research procedure carried out, the words *university, industry* and *cooperation* were used as search topic and 1930 articles were found. However, as the objective of this article is to understand how the cooperation between these two main actors takes place, what influences it and the results of that cooperation, the research was narrowed using the words "university" AND "industry" in topic and the word "cooperation" in title. The search conducted found 534 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 from 534 articles to 71.

Finally, these 71 articles were submitted to the VOSviewer software where we started by "create a map based on bibliographic data", with the articles collected from the WoS database. After, we select "bibliographic coupling" and without a "minimum number of citations of a document" and "4" as "minimum of cluster size". The application of the software allowed the identification of four clusters, leaving only 52 articles. The research was conducted on December 2020.

The research protocol is presented in Fig. 1 and Table 1 presented the criteria for inclusion and exclusion used in this study.

3 Results

3.1 Descriptive results

Figure 2 shows the evolution of publications and citations of the 71 articles obtained for analysis from 1991 to 2020. The number of citations has evolved over the years and peaked in 2019, with 244 citations. As far as the total number of articles is concerned, the peak was reached in 2016.

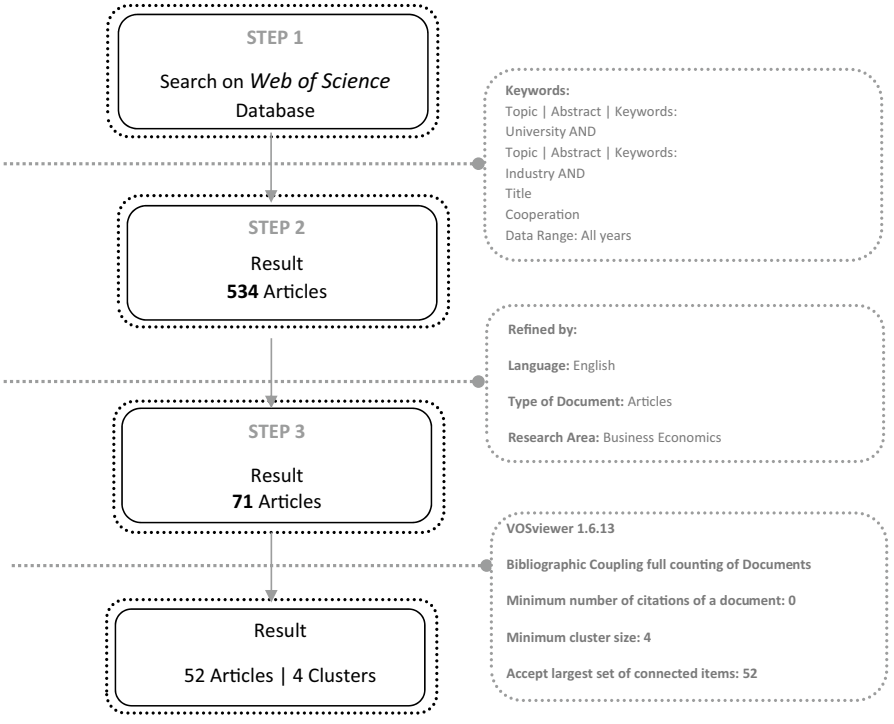

Fig. 1 Research protocol

Table 1 Criteria for inclusion and exclusion of publications in the SLR

Criteria for inclusion	Criteria for exclusion
Published in the period: December 2020	In Web Of Science database search were excluded proceedings paper, editorial material, book review, early access, meeting abstract, review, letter and note
Presence on Web of Science database	
Included in Business Economics areas	The VOSviewer software Bibliographic Coupling with full counting of documents analysis was performed with 0 citations of a document and considering a minimum cluster size of 4 authors
Articles published in English	
Referring explicitly to Cooperation in the title	

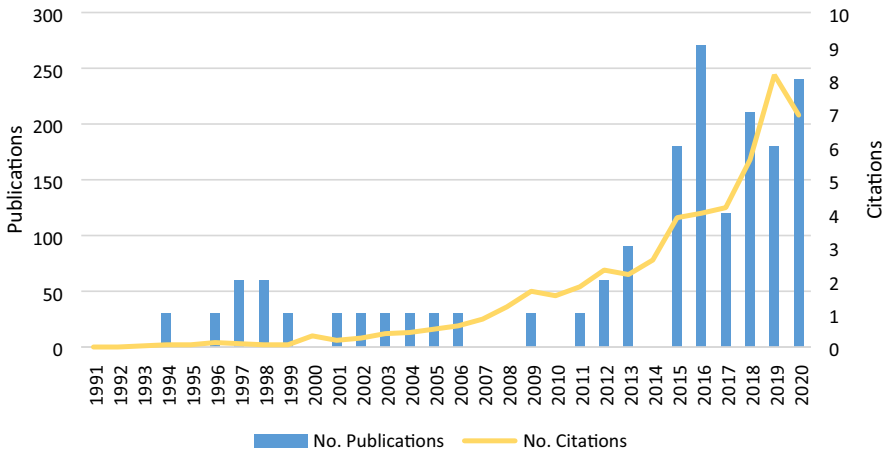

Fig. 2 Evolution of the number of publications and citations

14 of the 71 articles obtained in the survey (19.72%) had never been cited and 42 of them (59.15%) had less than 10 citations. The most cited article explores the characteristics of the companies that are more conducive to cooperation with universities (Veugelers and Cassiman 2005).

Analyzing the Fig. 2, it is still possible to verify that in the years 2007, 2008 and 2014, although there were no publications, citations appear. This fact is explained due to a possible gap between the year in which the articles are cited and the year in which they are actually published.

The 71 articles were published in 36 different journals. Table 2 shows the top of the 15 articles with most citations.

Table 3 shows the ten most cited articles. Analyzing Table 1, it is possible to verify that seven of the ten most cited articles are published in the two journals with

Table 2 The 15 of journals with most citations

Name of journal	Number of citations
Research Policy	582
Technovation	119
International Journal of Technology Management	116
Journal of Technology Transfer	86
R D Management	76
Journal Engineering and Technology Management	50
E & M Ekonomie a Management	24
Technology Analysis Strategic Management	18
Entrepreneurship and Sustainability Issues	9
SRA Journal of the Society of Research Administrators	9
Economics of Innovation and New Technology	7
Science and Public Policy	7
European Journal of Management and Business Economics	5
European Journal of Innovation Management	3
Journal of the Knowledge Economy	2

the most publications (see Fig. 3). On the other hand, it is also possible to see that most articles, about seven, follow a quantitative methodology, which demonstrates the need to understand and explain a certain phenomenon (Sánchez-Algarra and Anguera 2013), in this specific case the U–I cooperation.

To identify different trends guiding the literature on U–I cooperation, this research was divided into *clusters*, based on a *bibliographic coupling* analysis. 52 articles made it to the final stage. That way, four clusters (see Fig. 3—VOSviewer image) were obtained as a result of the analysis of the 71 articles. Those clusters are (1) motivations and barriers to U–I cooperation, (2) determinant factors, (3) government measures, (4) intersector technological cooperation.

3.2 Content results

3.2.1 Cluster 1: Motivations and barriers to cooperation

Table 4 presents the articles that are included in cluster 1 that deal with motivations and barriers one may have to face during the implementation of a cooperation process.

Social network analysis allows us to perceive how network members can influence each other through information exchange and the use of other resources. Since U–I cooperation is of great importance to global economic competitiveness, it is crucial to understand how these relations are established within a network context, more specifically in R&D, allowing the recognition of preferential relations between

Table 3 The 10 most cited articles

Article	Authorslyear	Journal	Total amount of Citations	Methodology
R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing	Veugelers and Cassiman (2005)	International Journal of Industrial Organization	279	Quantitative Analysis performed with 325 Belgian enterprises (econometric analysis)
R&D cooperation and failures in innovation projects: Empirical evidence from French CIS data	Lhuillery and Pfister (2009)	Research Policy	162	Quantitative Analysis performed with French companies with more than 19 employees (econometric model)
The changing structure of the US national innovation system: implications for international conflict and cooperation in R & D policy	Mowery (1998)	Research Policy	95	Qualitative Analysis comparing firms from the USA, Japan, France, Germany and the United Kingdom
Cooperation with public research institutions and success in innovation: Evidence from France and Germany	Robin and Schubert (2013)	Research Policy	79	Quantitative Analysis based on questionnaires that provided a sample of 20,676 French companies and 5200 German companies (econometric analysis)
Faculty support for the objectives of university–industry relations versus degree of R&D cooperation: The importance of regional absorptive capacity	Azagra–Caro et al. (2006)	Research Policy	77	Quantitative Analysis based on 872 questionnaires carried out in the 5 public universities located in the Valencian Community
Science and Technology Parks and cooperation for innovation: Empirical evidence from Spain	Vásquez-Urriago et al. (2016)	Research Policy	55	Quantitative Analysis based on 653 questionnaires applied to the Spanish companies located in Science and Technology Parks
University–industry cooperation: Researchers' motivations and interaction channels	Franco and Haase (2015)	Journal of Engineering and Technology Management	49	Qualitative Analysis based on a case study (interviews and documentary analysis) applied in a medium-sized higher education institution in Portugal

Table 3 (continued)

Article	Authorslyear	Journal	Total amount of Citations	Methodology
Stimulation of technology-based small firms—A case study of university–industry cooperation	Klofsten and Jones-Evans (1996)	Technovation	46	Qualitative Analysis based on an analysis conducted in a case study developed in Sweden
Technological innovation and inter-firm cooperation: an exploratory analysis using survey data from manufacturing firms in the metropolitan region of Vienna	Fischer and Varga (2002)	International Journal of Technology Management	44	Quantitative Analysis based on 204 questionnaires applied to industry companies with more than 20 employees located in the metropolitan area of Vienna
Transnational cooperation and policy networks in European science policy-making	Grande and Peschke (1999)	Research Policy	43	Quantitative Analysis based on interviews conducted with European Officials and on questionnaires applied to transnational companies

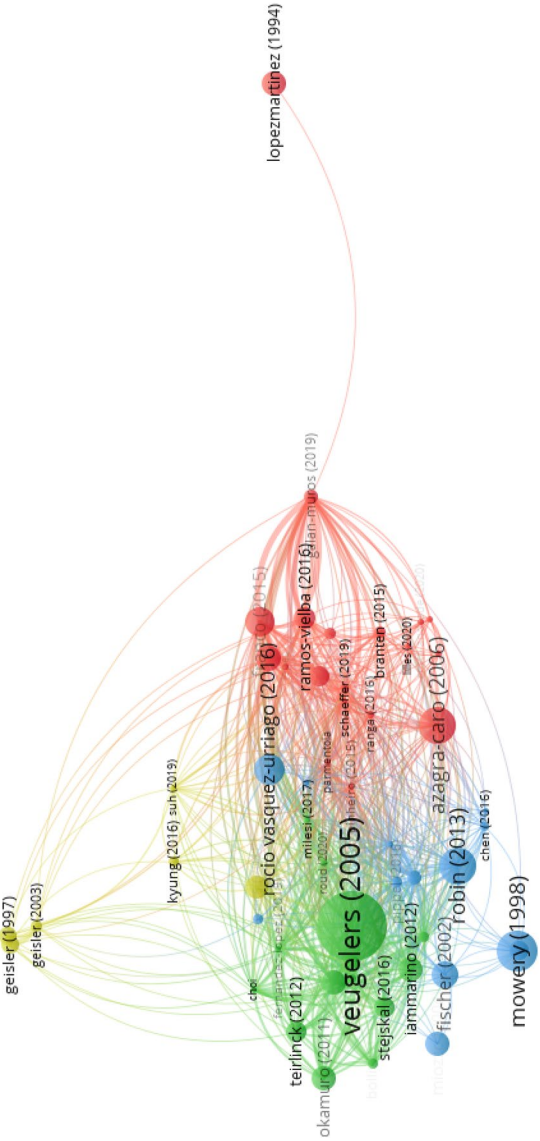

Fig. 3 VOSviewer image

Table 4 Articles that are part of *cluster* 1

Authors	Article	Objective	Methodology/Sample	Main conclusions
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	To understand how regions analyze innovation through the pressure exerted on European Universities to cooperate with their environment	Quantitative/ Teaching staff of the 5 Public Universities from the Valencian Community (Spain)	Regional characteristics are factors that have to be considered when one aims at promoting cooperation. On the other hand, European universities are pressured to cooperate with the industry, but regions with low absorptive capacity do not respond to university cooperation encouragement
López-Martínez et al. (1994)	Motivations and obstacles to university–industry cooperation (UIC): a Mexican case	To understand which are the motivations for university researchers to carry out technical research and cooperate with industry, which are the main motivations for the industry to seek cooperation with universities and which are the main barriers to cooperation	Quantitative/ 31 researchers from the National University of Mexico and 28 Mexican entrepreneurs	Cultural and political differences, as well as individual characteristics, may affect U–I cooperation. On the other hand, previous experiences may be taken into account in future cooperation agreements
Franco and Haase (2015)	University–industry cooperation: Researchers' motivations and interaction channels	To examine the interface between researchers' motivations and interaction channels concerning U–I cooperation	Qualitative/ Interviews with the President and the vice-president of a Portuguese polytechnic institute and documentary analysis	Universities and their researchers must try their best to carry out high-quality research projects through different kinds of cooperation. On the other hand, traditional universities use bi-directional channels that will play an important role in the interaction with the industry

Table 4 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Galán-Muros and Plewa (2016)	What drives and inhibits university-business cooperation in Europe? A comprehensive assessment	To analyze a set of factors that drive or inhibit U–I cooperation	Quantitative/ European teachers from 33 countries	Different U–I cooperation agreements are affected by barriers or drivers. However even if academics deny the existence of barriers that may hinder cooperation, they may not cooperate with industry if there are no drivers in place to encourage them. Another aspect that must be taken into account throughout U–I cooperation projects are government policies
Ramos-Vielba et al. (2016)	Scientific research groups' cooperation with firms and government agencies: motivations and barriers	To analyze the motivations and perceived perceptions of risk that shape the scientific research groups' cooperation with industry and government partners	Quantitative/ 851 research groups leaders	The motivations to engage in cooperation depend on the type of organization involved. However, being motivated to engage in cooperation may reduce the perceived risk
Branten and Purju (2015)	Cooperation projects between university and companies: process of formation and objectives of the stakeholders	To analyze the cooperation between universities and companies to facilitate and promote cooperation projects	Mixed/case study with a transport company and statistical analysis with an electronics company	The quality of information available and the level of management involvement are seen as factors contributing to the success of the project

Table 4 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Rampersad (2015)	Developing university-business cooperation through work-integrated learning	To analyze U–I cooperation through worked-integrated learning (WIL)	Qualitative/case study with an Australian University between 2012 and 2013	WIL plays an instrumental role at the U–I cooperation interface in contributing to broader cooperation outcomes. The organizations and individuals involved in communication and coordination processes play a crucial role that will lead to the outcomes expected from U–I cooperation
Galan-Muros and Davey (2019)	The UBC ecosystem: putting together a comprehensive framework for university-business cooperation	To put together the right pieces to create an integrated and comprehensive conceptual U–I cooperation framework for higher education institutions, the UBC ecosystem	Qualitative	Development of a *framework* that illustrates the components present in the U–I cooperation environment such as inputs, activities, outcomes, outputs, impacts, support mechanisms, circumstances and context
Ranga et al. (2016)	The new face of university-business cooperation in Finland	To analyze the development of U–I cooperation in Finland in the context of the *University Act* of 2009	Qualitative/case study with 4 universities (Aalto University, University of Jyväskylä, University of Turku, and Lappeenranta University of Technology)	The *University Act* of 2009 had an uneven effect on the 6 U–I cooperation dimensions and the "motivations" dimension was the most affected
Schaeffer (2019)	The use of material transfer agreements in academia: A threat to open science or a cooperation tool?	To characterize the restrictions imposed by MTAs- *Material Transfer Agreement*- and their determinants	Quantitative/ projects from French Universities of Strasbourg (Unistra) and Grenoble Alpes (UGA) between 2005 and 2014	The presence of an industry actor is not associated with more restrictions on publication and intellectual property

Table 4 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Deák and Szabó (2016)	Assessing Cooperation between Industry and Research Infrastructure in Hungary	To examine the research infrastructure developed by the academic sector	Quantitative/Research conducted in Hungary in 2014	Presents a starting point for developing measures and setting up goals for each scientific field
Wong et al. (2018)	The innovative grant of university-industry–research cooperation: A case study for Taiwan's technology development programs	To help set up management mechanisms and assessment indicators	Qualitative/ Interviews	The Triple Helix model not only expresses the relationship between university, industry and government but also influences internal transformation within each of those spheres
Pinheiro et al. (2015)	Social network analysis as a new methodological tool to understand university-industry cooperation	To test the use of social network analysis as a new methodological approach to better understand U–I relationships in the context of R&D cooperation networks for innovation	Qualitative/ Case Study on a FP7 project network composed of 29 members. Data was collected in 2013	Social network analysis is suggested as a useful and relevant tool to understand and analyze I&D U–I cooperation at both personal and organizational levels. Unlike other tools, social network analysis allows the recognition of preferential relations between institutions and reveals internal asymmetries
Cristo-Andrade and Franco (2019)	Cooperation as a vehicle for innovation: a study of the effects of firm size and industry type	Compare the actors involved in cooperation for innovation between Brazilian small- and medium-sized enterprises (SMEs) and large firms (LFs)	Quantitative/Data of 25,612 firm from PINTEC database (1998–2014)	Factors such as the proximity of SMEs to their customers and the structures of large companies, lead companies to belong to business groups and to connections to training centers and technical assistance networks

Table 4 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Lilles et al. (2020)	Comparative View of the EU Regions by Their Potential of University–Industry Cooperation	Evaluate and compare the potential of different regions of the European Union to support university-business cooperation as an important precondition for the implementation of the smart specialization strategy	Quantitative/ 154 regions all over Europe. Database used was Regional Innovation Scoreboard 2014 and Eurostat, Academic Ranking of World Universities	Three independent dimensions were identified that describe the potential of the regions to support U–I cooperation, namely the supporting role of the public sector, the supporting role of the private sector and the supporting role of universities. On the other hand, it was possible to verify that in many European countries there is not enough governmental support to be able to benefit from the smart specialization approach
Lopes and Lussuamo (2020)	Barriers to University–Industry Cooperation in a Developing Region	Analyze the barriers to university-business cooperation in academic region III, in the Angolan context	Qualitative/ Case study with semi-structured interviews	The lack of inter-organisational trust, low experience level, weak growth of the business fabric, the distance and / or geographic discontinuity of the university's headquarters are frequent barriers in the U–I relationship

Table 4 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Orazbayeva et al. (2019)	The Future of University–Business Cooperation: Research and Practice Priorities	Identify a portfolio of areas and topics perceived as high priority in the future of UBC academic research and the UBC managerial practice	Mixed/ Qualitative through the analysis of 121 responses collected (16 European and 5 non-European countries) and Quantitative through the analysis of 1190 online responses received from higher education institutions (HEIs) and companies in 33 countries	The interconnectedness of research and practice will be of critical importance for the future development of both domains. Only the joint efforts of UBC researchers and practitioners will enable a leap forward for everyone involved
Parmentola et al. (2020)	Exploring the university-industry cooperation in a low innovative region. What differences between low tech and high tech industries?	Explore patterns of U–I cooperation in four industry-specific clusters in the low-innovative region of Campania (Italy) with regard to motivations, barriers and cooperation channels	Qualitative/ semi-structured and face-to-face interviews	In low-innovative regions, sectoral differences in motivations, channels and barriers of U–I cooperation are less clear-cut or come in different forms than in highly innovative regions
Teixeira et al. (2019)	The knowledge transfer and cooperation between universities and enterprises	Analyze how knowledge transfer occurs between the higher education sector and companies	Quantitative/ questionnaire administered through telephone to 500 companies in Portugal	There is cooperation between companies and institutions of higher education when entrepreneurs are younger, and companies are located in urban areas

U–I and the asymmetries that are generated within R&D networks (Pinheiro et al. 2015).

It is extremely important to obtain a deeper knowledge about the motivations that drive university to cooperate with industry and industry to cooperate with university (López-Martínez et al. 1994; Franco and Haase 2015; Galán-Muros and Plewa 2016). This cooperation allows the transfer of knowledge and technology (Franco and Haase 2015; Galán-Muros and Plewa 2016; Teixeira et al. 2019), which are considered essential and being conducive to greater innovation and also to a better financial performance (Teixeira et al. 2019).

Knowledge transfer projects and U–I cooperation have become increasingly important in today's society. Therefore, both parties should be actively involved in the analysis of the process and the objectives of such cooperation projects should be clear. To further promote and facilitate the cooperation process, partners can use continuous monitoring of the objectives and analyze the feedback received regarding the same (Branten and Purju 2015). The transfer of material and scientific data is fundamental for knowledge creation and is being increasingly controlled by the use of Material Transfer Agreements (MTA). That way, each contract is adapted to the parties involved (Schaeffer 2019).

Understanding which factors may drive or inhibit U–I cooperation is fundamental (Galán-Muros and Plewa 2016; Ramos-Vielba et al. 2016). Hence the need to understand the nature of those cooperation activities, because drivers will seemingly affect all the activities developed but barriers won't have the same effect on all activities (Galán-Muros and Plewa 2016). Only the joint effort of researchers and professionals will allow everyone involved to achieve their goals, while taking into account the related political measures that must be taken (Orazbayeva et al. 2019). For companies, U–I cooperation can offer specialized skills in the commercialization of their products and services (Rampersad 2015), and allows the use of research infrastructure is one of the most logical and apparent usages of universities' resources and is widely considered as important as basic R&D for innovation (Deák and Szabó 2016). For universities, and since alumni and employers play an important role, it will be crucial for them to get involved in cooperation processes, namely through WIL program—Work-Integrated Learning (Rampersad 2015). For universities, the reasons for cooperation are linked to the fact that cooperation is vital for their research, that this strategy will help them fulfil a strategic mission that involves cooperation with their surroundings and because it represents a way of obtaining additional financial resources (Franco and Haase 2015), the type of partner organization involved, a situation that may act as an inducement to develop partnerships with government agencies, and the search for new opportunities to apply acquired knowledge, that will primarily motivate partnerships with business firms (Ramos-Vielba et al. 2016) and the commercialization of products and services (Rampersad 2015).

There are several motivations that lead to better U–I cooperation, such as the age of entrepreneurs, the location of companies in urban areas (Teixeira et al. 2019), the size of the company and the proximity of SMEs to their customers (Cristo-Andrade and Franco 2019).

Lilles et al. (2020) identified three independent dimensions that describe the potential of the regions to support U–I cooperation, namely the supportive role of the public sector, the supportive role of the private sector and the supporting role of universities, with the regions having a very heterogeneous character as to the ability to support U–I cooperation. In low-innovative region, the sectoral effect on U–I cooperation has different implications when compared to highly innovative regions (Parmentola et al. 2020). In developed countries, much of the R&D work is carried out in universities, as they are responsible for most of the research conducted (Deák and Szabó 2016).

However, it is also crucial to understand the kind of barriers that exist in cooperation agreements. The cultural differences, government policies, the ideology of the individuals involved in partnerships (López-Martínez et al. 1994), bureaucracy, the legal framework and the lack of organizational support, the lack of accountability of researchers (Franco and Haase 2015), scientific risks (autonomy and credibility) (Ramos-Vielba et al. 2016), socio-economic conditions, such as the prevalence of SMEs, the lack of tradition in science-based cooperation (Azagra-Caro et al. 2006) and the lack of mutual trust (Parmentola et al. 2020) are seen as barriers to cooperation. According to Lopes and Lussuamo (2020) the lack of interorganizational trust and the low level of experience, the weak growth of the business fabric, the distance and/or geographic discontinuity of the university's headquarters may also constitute one barriers to cooperation.

U–I cooperation is growing fast, and it takes place mainly in dynamic innovation and entrepreneurship environments (Ranga et al. 2016). It is well-known and accepted that the bilateral relationship between higher education institutions and business firms has contributed to economic development. However, it is still a fragmented and indistinct field of research (Galan-Muros and Davey 2019). Assuming that U–I cooperation is desirable, it should be backed by policy measures, always taking into consideration the regional context in which they will be implemented (Azagra-Caro et al. 2006) because they have generated changes in attitude, new approaches to education, research and entrepreneurship and new opportunities for collaboration (Ranga et al. 2016).

According to Wong et al. (2018), it is important to perceive how the use of government research grants in technology can be more efficient and to evaluate how to use university-industry-research cooperation (U–I-R) to promote industrial innovation (Galán-Muros and Plewa 2016).. Many regions do not appear to have sufficient governmental support (Lilles et al. 2020). Thus, successful U–I-R cooperation requires the following factors: strengthening review methods for the mechanisms, relationships of rights and obligations, the need for regulation policies, and the planning in operations. Thus, both universities and governments will have to focus on cooperation, particularly through the implementation of joint policies, to remove any barriers that may hinder such process (Galán-Muros and Plewa 2016).

Table 5 Articles that are part of *cluster* 2

Authors	Article	Objective	Methodology/Sample	Main conclusions
Veugelers and Cassiman (2005)	R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing	To analyze the characteristics of the companies that are more conducive to cooperation with universities	Quantitative/ 325 Belgian industry companies	The largest chemical and pharmaceutical companies are more likely to cooperate with universities whenever the risk is not a barrier to innovation, and when cooperation serves to share costs
Gallego et al. (2013)	Knowledge for innovation in Europe: The role of external knowledge on firms' cooperation strategies	To analyze the relationships between firms' external search for knowledge and its role in cooperation strategies for innovation	Quantitative/ 40 activity branches in 15 countries (Belgium, Bulgaria, Czech Republic, Germany, Estonia, Spain, France, Greece, Hungary, Italy, Lithuania, the Netherlands, Poland, Portugal, and Romania)	Firms' internal R&D effort and size are determinant factors explaining the establishment of cooperation agreements. Firms' external search for knowledge is another factor
Iammarino et al. (2012)	Technological Capabilities and Patterns of Innovative Cooperation of Firms in the UK Regions	To focus on the relationship between firms' technological capability and on how they can engage in cooperation for innovation	Quantitative/ 16,445 companies from the United Kingdom with ten or more employees	Cooperation within business groups, vertical cooperation (customers and suppliers) and cooperation with universities are significantly associated with firms' technological capacity. However, regional differences must be taken into account since they may produce some significant shifts in cooperation

Table 5 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Okamuro et al. (2011)	Determinants of R&D cooperation in Japanese start-ups	To explore the determinant of R&D cooperation in Japanese companies	Quantitative/ 1514 Japanese software industry companies	Founder-specific characteristics, namely those that have to do with training, work experience, and with prior innovation output, are crucial in determining the type of cooperation that will take place with universities and public research institutes. On the other hand, independent firms tend to engage more in R&D cooperation and firms that are used to invest more in R&D are more likely to cooperate
Teirlinck and Spithoven (2012)	Fostering industry-science cooperation through public funding: Differences between universities and public research centres	To analyze whether or not the funding granted by local governments and by EU programs will influence the cooperation between industry and science	Quantitative/ 1083 Belgian I&D companies	Funding by regional and local government promotes the instalment of R&D cooperation between industry and science
Stejskal et al. (2016)	The cooperation between enterprises: Significant part of the innovation process – A case study of the Czech machinery industry	To analyze the importance of cooperation between firms and other partners and the efficiency of public subsidies from national and European funds	Quantitative/ 5151 Czech firms with at least 10 employees	Cooperation between U–I have a positive impact on companies' innovation output and will affect both their products and their processes

Table 5 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Bolli and Woerter (2013)	Competition and R&D cooperation with universities and competitors	To analyze the relationship between competition and R&D cooperation with universities and competitors	Quantitative/ Data collected from Swiss companies in 1996, 1999, 2002, 2005 and 2008	The relationship between price competition and university cooperation takes the form of an inverted U-shape. Quality competition only matters for university cooperation and the relationship shows a U-form. On the other hand, the number of main competitors reduces the likelihood of cooperation between competitors
Badillo et al. (2017)	Cooperation in R&D, firm size and type of partnership: Evidence for the Spanish automotive industry	To analyze the heterogeneity in firms' decisions to engage in R&D cooperation, taking into account the kind of partner involved and the sector to which the firm belongs	Quantitative/ Data on Spanish companies retrieved from the Technological Innovation Panel (PITEC)	R&D intensity and the importance granted to the lack of qualified workers as a factor hampering innovation are key factors that influence positively R&D cooperation activities in the service sector but not in manufactures

Table 5 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Seo et al. (2017)	R&D cooperation and unintended innovation performance: Role of appropriability regimes and sectoral characteristics	To examine the relationship between R&D cooperation and unintended innovation performance	Quantitative/ Korea Innovation Survey (KIS), from 2012	In High-Tech firms under a strong appropriability regime, cooperation with competitors increases the likelihood of their innovation performance. In High-Tech firms where the appropriability regime is weaker, cooperation with customer and user firms and universities increases the likelihood of their unintended innovation performance. The same happens with low tech firms under strong or weak appropriability regimes
Fernández-López et al. (2019)	The funnel model of firms' R&D cooperation with universities	To explore the determinants of firms' R&D cooperation with research groups that understand U–I cooperation as a sequential process	Quantitative/ 375 Spanish, Portuguese and French companies	Innovative companies are more likely to show a more proactive attitude towards R&D cooperation. Factors that are inherent to each country affect U–I cooperation
Rõigas et al. (2018)	Which firms use universities as cooperation partners?—A comparative view in Europe	To compare the determinants of U–I cooperation across countries and to identify the differences between firms that cooperate with domestic universities and those that cooperate with foreign universities	Quantitative/ Data from 14 European countries retrieved from the 2008 Community Innovation Survey	The degree of internationalization is the main determinant of cooperation. Exporting or foreign-owned firms are more likely to cooperate with foreign universities

Table 5 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Milesi et al. (2017)	Science-industry R&D cooperation effects on firm's appropriation strategy: The case of Argentine biopharma	To show how science-industry R&D cooperation generates effects on the strategy developed by firms to appropriate the benefits of innovations	Qualitative/ Multiple Case study covering 9 biopharmaceutical Argentine firms	U–I R&D cooperation generates opposing effects on the various appropriation mechanisms used by firms. On the other hand, contract R&D, Internalization and Coordination affect differently the appropriation mechanisms used by firms
Choi and Choi (2020)	The effects of R&D cooperation on innovation performance in the knowledge-intensive business services industry: focusing on the moderating effect of the R&D-dedicated	Explore the effects of R&D cooperation (vertical, competitor and institutional cooperation) on four different kinds of innovation (service, process, organizational and marketing)	Quantitative/ Data from 956 companies retrieved from Korean Innovation Survey (KIS), from 2016	Vertical R&D cooperation has had a positive effect on the performance of the most technological service industries, especially on service and marketing performances. Horizontal R&D cooperation has a diversified effect on service industry innovation, as it depends on the type of cooperation established
Roud and Vlasova (2020)	Strategies of industry-science cooperation in the Russian manufacturing sector	Discuss the relevance of traditional assumptions about the relationship between industry and science for developing countries	Quantitative/ Data from 805 Russian manufacturing with more than 15 employees retrieved from Institute for Statistical Studies and the Economics of Knowledge (ISSEK), 2014–2015	In countries where innovation systems are less developed and with levels below the average of technological opportunities, U–I cooperation is influenced more by the specificity of economic activity and the size of the company

3.2.2 Cluster 2: Determinant factors

Table 5 shows the articles which are part of cluster 2 that deals with determinant factors or in other words with the organization characteristics that influence the U–I cooperation process.

In recent years it has been possible to witness the growing importance of knowledge transfer in a global economy framework. Hence the need to systematically promote cooperation between firms and other partners and to create working groups that will have a positive impact on the growth of said firms (Stejskal et al. 2016). When a firm decides to engage in R&D cooperation, it has to take into account the type of partner it wants to work with. It can be either with competitors (horizontal cooperation), suppliers and customers (vertical cooperation) or research institutions (institutional cooperation) and the sector to which the company belongs (production or services) (Badillo et al. 2017). The cooperation between groups of firms, customers and suppliers and with universities is linked to the acquisition of new technological capabilities, like the introduction of new products or processes (Iammarino et al. 2012). According to Choi and Choi (2020), vertical R&D cooperation has had a positive effect on the performance of the most technological service industries, especially on service and marketing performances. Horizontal R&D cooperation has a diversified effect on service industry innovation, as it depends on the type of cooperation established. Industry and universities are two key players in the National Innovation System. The collaboration between them allows scientific progress to spread more quickly, and this cooperation can happen with national or foreign universities (Rõigas et al. 2018). However, U–I cooperation is merely one of the activities that companies should develop (Veugelers and Cassiman 2005). Thus, the firms' willingness to interact and relate actively with external agents has become crucial since the firms' innovative performance is based on their ability to establish a cooperation network with the scientific community that will include universities and other public research institutions (Gallego et al. 2013). Bolli and Woerter (2013) analyzed the relationship between the existing competitive environment and R&D cooperation with universities, considering the quality competition, and competitors, considering price competition. R&D cooperation will happen if the company's return increases, i.e. when benefits outpace cooperation cost. In this context, the return may be triggered by the so-called synergy effect, since cooperation leads to an increase in innovation productivity, and by the collusion effect, since cooperation may lead to an anti-competitive kind of behaviour.

According to Fernández-López et al. (2019), several determinants can explain R&D cooperation and although many firms showed interest in cooperating with universities, only a small percentage ended up cooperating. Therefore, cooperation should be analyzed as a two-step process, the first of which involves the interest in cooperating and the second involves the final decision to cooperate.

Understanding the determinants of R&D that may influence cooperation is fundamental (Okamuro et al. 2011; Iammarino et al. 2012). Thus, studies carried out point out as determinants the institutional setting, the industrial structure and organization (size, belonging to a corporate group, degree of international openness) and the network relationships which are peculiar to each regional system (Iammarino

et al. 2012), sector of activity (Veugelers and Cassiman 2005; Rõigas et al. 2018; Roud and Vlasova 2020), the size of the firm (Veugelers and Cassiman 2005; Gallego et al. 2013; Badillo et al. 2017; Rõigas et al. 2018; Roud and Vlasova 2020), spillovers, local, regional and national public funding (Stejskal et al. 2016; Badillo et al. 2017; Rõigas et al. 2018), the motivation for choosing to engage in R&D cooperation (Badillo et al. 2017), innovation activities, internationalization, number of linkages (Rõigas et al. 2018). According to Milesi et al. (2017), cooperation strategies are more likely to take place in a developing country and in dynamic and intensive sectors where companies are market oriented.

Okamuro et al. (2011) conducted a study where they could analyze which specific characteristics such as those of the founder, of the company itself or the industry, may influence the choice of partners. Founder-specific characteristics such as educational background, prior innovation output and affiliation to academic associations will affect cooperation with universities or public research institutes, and founders' work experience and previous innovation output will affect the companies' cooperation with business partners. Concerning firm-specific characteristics evidence shows that those investing more in R&D tend to engage in R&D cooperation regardless of the type of partner, while independent firms are less likely to cooperate with universities.

Despite its unstable nature and the risks and failures that can arise from R&D cooperation, these resources can bring unintended success. Thus, high-tech focal firms, under a strong appropriability regime, will be more likely to cooperate with competitors and to increase the likelihood of their unintended innovation performance. On the other hand, high-tech focal firms under a weak appropriability regime will be more likely to cooperate with users firms, customers and universities. Low-tech firms, under a strong appropriability regime, will favour cooperation with the customers and advisory organizations. For the low-tech companies under a weak appropriability regime, cooperation with competitors, government research institutes increases the likelihood of unintended innovation performance (Seo et al. 2017).

As universities are considered important partners, companies that cooperate with them will show a more positive overall performance. Therefore, it will be necessary to adopt public policies that can support this cooperation (Stejskal et al. 2016; Roud and Vlasova 2020).

Governments have become increasingly interested in issues related with the efficiency and effectiveness of public R&D funding, as they want to assess the outcome of public support, namely when the cooperation between industry and science is involved. According to Teirlinck and Spithoven (2012), when we focus on cooperation, one has to take into account the R&D partner, i.e. if one is dealing with universities or public research centers, because funding by regional governments has a positive effect in the case of cooperation with public research centers. On the other hand, public funding granted by European Union programs did not exert an impact on the cooperation between industry and science, neither with universities nor with public research centers.

Table 6 Articles that are part of *cluster* 3

Authors	Article	Objective	Methodology/Sample	Main conclusions
Mowery (1998)	The changing structure of the US national innovation system: Implications for international conflict and cooperation in R & D policy	To summarize recent trends in the structure of the US national innovation system	Qualitative/comparison between firms from the USA, Japan, France, Germany and the United Kingdom	Efforts to limit the dissemination of the results of publicly funded R&D and the access of foreign-based companies to EU R&D programs have failed
Robin and Schubert (2013)	Cooperation with public research institutions and success in innovation: Evidence from France and Germany	To evaluate the impact of cooperation with public research on product and process innovation in French and German firms	Quantitative/20,676 French firms and 5200 German firms (manufacturing firms with more than 20 employees)	Cooperating with public institutes increases product innovation, but does not affect process innovation. This increase is much higher in Germany than in France
Fischer and Varga (2002)	Technological innovation and interfirm cooperation. An exploratory analysis using survey data from manufacturing firms in the metropolitan region of Vienna	To identify 5 types of networks that might have been created by firms located in Vienna and to explore to what extent the likelihood of cooperation between firms is conditioned by their general profile and their technological resources	Quantitative/Questionnaires applied in the Metropolitan region of Vienna and that involved a sample of 204 manufacturing firms with less than 20 employees	Networking is not yet a popular concept among the manufacturing firms located in Vienna and when cooperation exists, networking activities are developed with customers, manufacturer suppliers and producer services providers. On the other hand, firms tend to rely on sources of technology from national and especially international networks

Table 6 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Miozzo and Dewick (2004)	Networks and innovation in European construction: Benefits from inter-organisational cooperation in a fragmented industry	To explore the relationship between inter-organizational networks and innovation in the construction industry	Qualitative/Interviews with firms, representatives of government, quasi-government bodies, research institutes, architects and customers in 5 European countries (Denmark, France, Germany, Sweden and the United Kingdom)	Inter-organizational cooperation may be responsible for industry performance through the strengthening of the relationships between contractors and subcontractors or with the suppliers of material, the government, universities, architects or engineers, customers and international cooperations
Fujisue (1996)	Promotion of academia-industry cooperation in Japan— establishing the "law of promoting technology transfer from university to industry" in Japan	To analyze U–I cooperation in Japan	Qualitative	Cooperation paradigm in Japan is shifting quickly. Industry, academia and government have to once and for all accept the roles they have to play to promote further cooperation
Vásquez-Urriago et al. (2016)	Science and Technology Parks and cooperation for innovation: Empirical evidence from Spain	To analyze the effect that location in technology parks may have on cooperation for innovation and the mechanism that facilitates such effect	Quantitative/653 Spanish firms located in Science and Technology Parks	The location in Technology Parks increases the likelihood of cooperation for innovation and the intangible benefits from cooperation mainly due to highly diversified relationships
Alves et al. (2015)	On the role of the university in the promotion of innovation: Exploratory evidence from a university-industry cooperation experience in Brazil	To examine U–I interaction in pursuit of innovation	Qualitative/Bibliographical review and a case study involving two public universities and 4 firms located in São Paulo	New policies are required to promote a certain level of U–I cooperation in Brazil in which universities might have a better grasp of the positive economic externalities arising out from cooperation

Table 6 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Chen et al. (2016)	A New Approach for the Cooperation between Academia and Industry: an empirical analysis of the Triple Helix in East China	To analyze cooperation relationship through a thorough inquiry of the influence of cooperation in high-tech firms	Quantitative/696 high-tech firms and 65 universities	High-tech firms can improve their economic situation engaging in cooperation agreements with universities. Their economic performance is related to the existing cooperation projects. Different cooperation projects will lead to different economic performances of firms
de Moraes Silva et al. (2018)	University–industry R&D cooperation in Brazil: a sectoral approach	To discuss the relevance of traditional hypotheses on U–I liaisons in developing countries	Quantitative/PINTEC database that includes 55 sectors of extractive and production industries	Size, extramural R&D and product innovativeness are the most important determinants of U–I-cooperation
Pippel and Seefeld (2015)	R&D cooperation with scientific institutions: A difference-in-difference approach	To identify the relationship between R&D cooperation with scientific institutions and the product and process innovation performance of firms	Quantitative/560 German manufacturing and service firms	R&D cooperation with universities and governmental research institutes has a positive impact on both product innovation and process innovation performance of firms
Merritt (2015)	The Role of Human Capital in University–Business Cooperation: The Case of Mexico	To answer the question: will Mexican industrial firms be able to benefit from the knowledge produced in universities?	Quantitative/Mexican firms	Larger firms have a greater capacity to absorb knowledge generated by universities due to their higher level of human capital

Table 6 (continued)

Authors	Article	Objective	Methodology/Sample	Main conclusions
Moraes Silva et al. (2020)	Internal barriers to innovation and university-industry cooperation among technology-based SMEs in Brazil	Investigate the association between internal barriers to innovation and the propensity of technology-based SMEs to cooperate with universities and research institutes (URIs)	Quantitative/3736 firms from database of Brazilian Innovation Survey (PINTEC)	Financial obstacles are shown to be strongly related to the propensity of KIBS to collaborate with URIs. Knowledge obstacles are moderately related to the propensity of high-tech manufacturing SMEs to collaborate with URIs
Ran et al. (2020)	An improved solution for partner selection of industry-university cooperation	Propose an improved solution to resolve the 4 W issues commonly faced by SMEs, including identifying cooperation topics, comparing technology competitors, evaluating cooperative universities and selecting research teams	Quantitative/8799 documents from Chinese Patent Full-text Database (CPFD) without time limiters (the collected patent documents there were collected from 1639 companies and 152 universities)	Proposal for a new index called TMI to assist the process and decision making of partner selection

3.2.3 Cluster 3: Government measures

Table 6 shows the articles that form *cluster* 3 and addresses the topic related to government action, namely the impact it may have on the cooperation process through the measures implemented, the support provided and the laws issued.

Companies, especially SMEs, they need to cooperate with external agents to improve their technological capabilities (Ran et al. 2020). The innovation process is seen as a technical and social process because it involves the interaction between individuals both internally within the company and externally with other companies. The concept of networking in industry firms does not yet seem to be very popular and when it does exist, networking is essentially based on vertical cooperation with customers, suppliers and producer service providers, and there is no place for horizontal cooperation (Fischer and Varga 2002). The strength of inter-organizational cooperation may be responsible for the improved performance of the industry, because it makes possible the use of knowledge and technologies that have been generated by different organizations, namely subcontractors or suppliers, government, universities, architects or engineers, customers and international collaborations (Miozzo and Dewick 2004). U–I cooperation has proven to be an effective way to acquire the technological skills necessary to survive in a competitive context. To this end, the selection of partners is a fundamental key factor for the success of the cooperation (Ran et al. 2020). The participation of firms in publicly funded technology development projects can convey great learning benefits (Mowery 1998).

Since inter-organizational relationships are of paramount importance for innovation and competitiveness, governments will be responsible for taking the appropriate measures and for granting all the support this cooperation needs to develop effectively (Miozzo and Dewick 2004).

Economists and business managers have long been interested in cooperation with scientific institutions, notably for their R&D results. According to Pippel and Seefeld (2015), cooperation can be established with two different types of scientific institutions, universities and governmental research institutes, and both partnerships have a positive effect on product innovation and the process innovation performance of firms. Robin and Schubert (2013) disagree stating that cooperation with public research increases product innovation but does not affect process innovation. U–I cooperation has gained increased attention because universities are expected to contribute to the development of the economy, mainly with the creation of new businesses (Fujisue 1996). Thus, it is hoped that this cooperation will allow creating value and generating new knowledge (Alves et al. 2015). However, as far as policy implications are concerned, public–private cooperation should not be encouraged at all costs, as it may not benefit all forms of innovation (Robin and Schubert 2013). De Moraes Silva et al. (2018) analyzed the determinants of U–I cooperation by dividing them into two groups of distinct variables, the internal and the external characteristics. As for the internal characteristics, they assessed the size of the firm, product innovation and process innovation. Moraes Silva et al. (2020) also refer financial factors and knowledge as internal obstacles. As for the external characteristics, they assessed the market and government policies, such as economic risk, innovation cost and government funding (de Moraes Silva et al. 2018).

Although governments have been struggling to encourage U–I cooperation, the fact is that this kind of collaboration is still quite weak (Merritt 2015). Mowery (1998) summarized the trends in the structure of the US national innovation system and noted a decline in government R&D spending, a reduction in basic research funded by industry, some other policy-related changes like the introduction of programs that seek to strengthen U–I cooperation and the collaboration between laboratories and industry. According to Merritt (2015), because of this, university research has evolved according to the interests of scientists, also because of the weakness of the companies' R&D. Since human capital is fundamental to such a process, larger companies have to be able to absorb the knowledge generated by universities. On the other hand, smaller companies face serious obstacles as they lack qualified engineers and technicians to invest in R&D. As such, governments, through their public policies, should encourage and support the hiring of skilled and qualified human capital.

The Triple Helix model, i.e., the U–I–G cooperation, is currently accepted as a significant determinant for innovation. It must be healthy and productive to maximize profits. The use of platforms is a solution to foster cooperation between high-tech firms and universities. Thus, the number of cooperation projects is one of the factors that may influence economic performance. On the other hand, high-tech companies that select different cooperation models on the platform will have different economic performances. To overcome the obstacles that may inhibit U–I cooperation, it is essential to maintain an effective communication system (Chen et al. 2016).

Government support is essential to help overcome the perceived barriers by promoting problem-solving policies and clear and precise rules so that the objectives set by both parties involved in cooperation (U–I) can be achieved (Alves et al. 2015), creating policies through support in academic industry R&D and the establishment of technology licensing offices (Fujisue 1996).

According to Vásquez-Urriago et al. (2016), the creation of Science and Technology Parks was one of the most essential innovation policies initiatives. The location of companies in these parks has a positive effect on innovation cooperation and the intangible benefits of said cooperation, mainly due to the higher diversity in the relationship. However, it is difficult to perceive whether or not the results obtained through such cooperation will be better.

However, the interaction between university and industry has not yet reached its peak (Alves et al. 2015).

3.2.4 Cluster 4: Intersector Technology Cooperation

Table 7 lists the articles that belong to cluster 4 that addresses the topic of U–I cooperation being based on intersector technology cooperation that may bring great benefits through the transfer of knowledge and technology.

Intersector Technological Cooperation (ITC) can be an effective means to promote the firm competitiveness and has therefore gained increased public and academic interest. There are several myths involving ITC, more precisely myths associated with U–I cooperation, university-government cooperation and industry–government

Table 7 Articles that are part of *cluster* 4

Authors	Article	Objective	Methodology/sample	Main conclusions
Geisler (1997)	Intersector technology cooperation: Hard myths, soft facts	To analyze the literature on intersector technology cooperation	Qualitative	Intersector cooperation is a complex phenomenon but it is feasible and produces some results that benefit all the cooperating parties
Geisler (2001)	Explaining the generation and performance of intersector technology cooperation: A survey of the literature	To analyze the factors that affect the generation and performance of U–I and industry-federal laboratories cooperation	Qualitative	The factors that affect decisions to initiate intersector cooperation are different from those that are used to measure success. Legal and organizational barriers are different according to cultural discrepancies. That way, governments will be responsible for drawing up policies to foster better cooperation
Geisler (2003)	Benchmarking inter-organisational technology cooperation: The link between infrastructure and sustained performance	To examine the effects of the infrastructure of IUCRCs on their sustained performance	Qualitative/ Study with 87 industrial firms and 12 additional firms	The decisions by industrial firms to join, remain or terminate a cooperation partnership with universities are three different phenomena. The infrastructure of cooperative arrangements is one of the main determinants of the success and survival of cooperation agreements
Szücs (2018)	Research subsidies, industry-university cooperation and innovation	To evaluate the innovation performance of subsidized firms, namely those where there is a U–I partnership	Quantitative/ subsidized under the 7th Framework Programme	The number of participants in the project positively affects academic quality standards, amplify U–I performance and benefits
Suh et al. (2019)	Analysing the satisfaction of university–industry cooperation efforts based on the Kano model: A Korean case	Propose a framework to analyse satisfaction with university–industry cooperation programs	Quantitative/ analysis of the 20 main factors of university-company cooperation using the Kano model	Division of 20 aspects considered essential when covering U–I in four categories (careful, concerned, nice and appropriate) as a way to improve satisfaction in cooperation

Table 7 (continued)

Authors	Article	Objective	Methodology/sample	Main conclusions
Kyung et al.(2016)	Factors Affecting University – Industry Cooperation Performance: study of the mediating effects of government and enterprise support	Determine the effects of government-funded R&D projects in the relationship between the competence factors of universities and the performance of university–industry cooperation	Quantitative/ data from 139 universities collected from "The Information Service of Higher Education in Korea" website (2011–2013)	The need for government funding for R&D projects to promote performance during university-industry cooperation

cooperation, which are often used to oversimplify the causes that contribute to the success or failure of the cooperation (Geisler 1997). According to Geisler (2001) ITC is a phenomenon that has grown in recent years and is a complex process that varies according to the stage of the life cycle of cooperation. This author analyzed the factors affecting the creation and performance of cooperation between U–I and between industry and government laboratories, and for him the motivations and objectives of cooperation should be well-identified according to each of the stakeholders. Cross-sector cooperation is feasible and may produce results that benefit all parties involved, but it is also a complex phenomenon since cooperation will only exist if all the participating parties are willing to (Geisler 1997).

While an external source of technology may appear attractive, due to the unique skills and capabilities it provides, this does not in itself ensure successful cooperation (Geisler 2001). There has been an increase in U–I cooperation to achieve harmonious development under the open innovation paradigm (Suh et al. 2019). It is then necessary for the government, through government funding or through other activities, to support R&D projects to promote performance during U–I cooperation (Kyung et al. 2016; Suh et al. 2019). On the other hand, legal and organizational barriers can pose difficulties both in terms of effective work and in cultural terms. Therefore, university and government policymakers will be expected to develop programs that will help enable such cooperation so that the desired outcomes can be achieved (Geisler 2001) namely by creating policies that suit reality and promote cross-sector cooperative technology efforts (Geisler 1997).

Szücs (2018) analyzed the impact that a large-scale R&D grant program could have on the innovation activities of the companies that had received said subsidies, more specifically concerning U–I cooperation. Therefore, the success of any R&D project will strongly depend on the number of participants and the actual funding received by companies. However, it is possible to distinguish between cooperation projects established with universities and research centres, because universities and their participants positively affect knowledge performance among project members. Research centers, on the other hand, do not have this impact.

For Geisler (2003) R&D cooperative efforts between U–I–G have been widely discussed and include cooperation between networks of government R&D/Technology laboratories, industrial R&D laboratories and universities. Structural factors play a significant role in the decision of companies to engage in cooperation agreements. The decisions by industrial enterprises to join, remain or terminate a cooperation partnership with universities are three different phenomena, influenced by different combinations of infrastructure dimensions. Thus, focusing on infrastructure is a way to assess the cooperation, whereas technology transfer may limit the assessment.

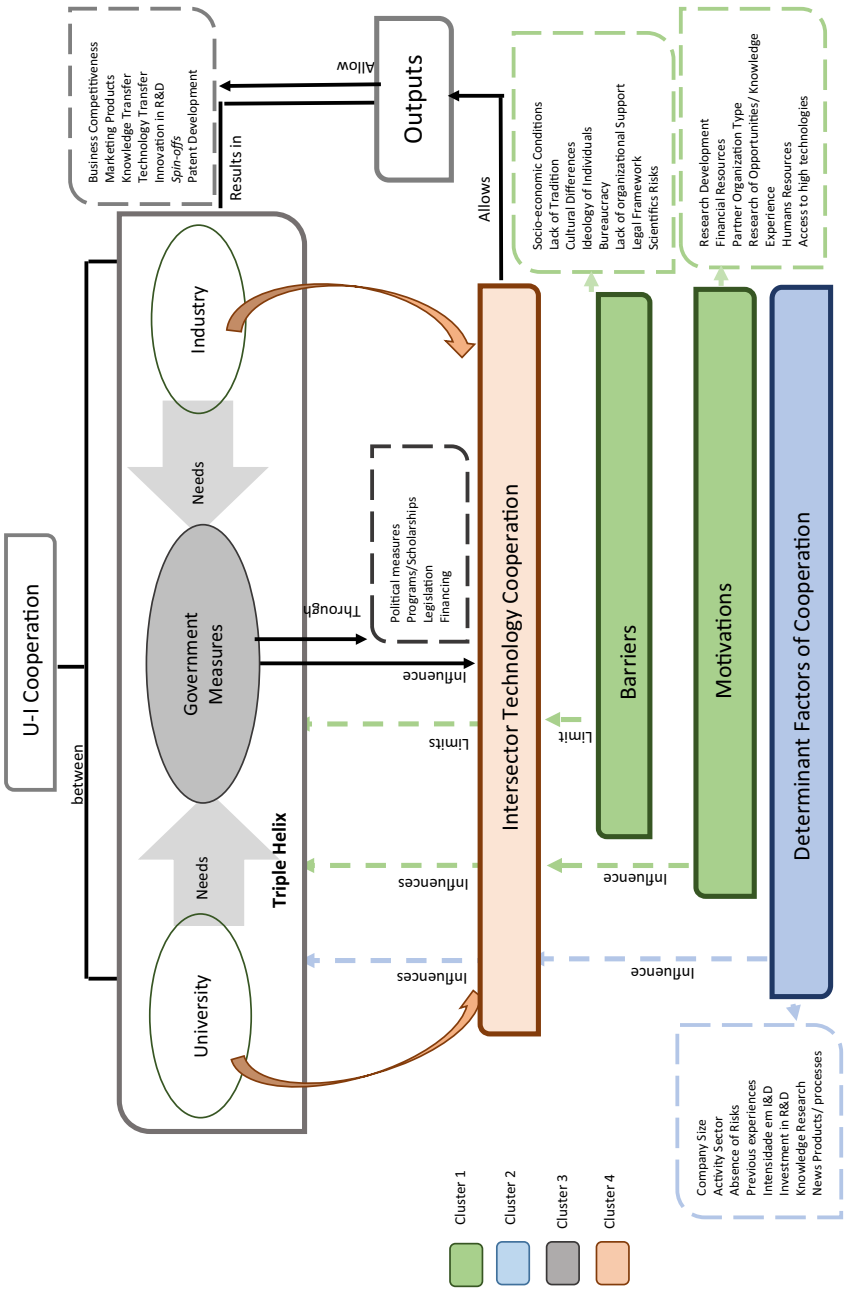

Fig. 4 Conceptual model

4 Discussion and future lines of research

Cooperation between U–I is fundamental and has gained increased attention from governments, policymakers and researchers. However, the literature on U–I cooperation considers that if the two actors adopt different attitudes, this disparity may originate great obstacles and fruitless collaborations.

Figure 4 summarizes and interconnects the four clusters obtained and that address topic like motivations and barriers to cooperation, determinants that influence cooperation, government measures and finally Intersector Technology Cooperation.

The analysis of our model makes it possible for us to see that the cooperation process can be influenced, positively or negatively, by several variables, that may have a greater or lesser impact on the process. Some of the variables that may influence cooperation positively or negatively are determinants, which are essentially associated to the characteristics of the company, the motivations and with the policies and measures that government should implement to foster cooperation. However, this process is also limited by barriers to cooperation and all the participating parties have to be aware of those perceived barriers to effectively minimize their impact. Those obstacles may be directly related to the firm and its characteristics or to the limitations imposed by the region where it is located or with which it intends to cooperate. On the other hand, it is also possible to talk about Intersector Technological Cooperation, which is still an example of U–I cooperation but on a more technology-oriented basis. As *outputs* of U–I cooperation, we have to highlight product and/or process innovation, patent development, knowledge and technology transfer, *spin-offs*, *royalties*, R&D projects and product commercialization.

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 the identification of 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 in order to assess which factors will favour and which will inhibit cooperation, as well as the outcomes of such cooperation.

From the literature reviewed, and based on the first cluster, and for cooperation to take place, some motivations must be identified and taken into account. However, most of the studies carried out in this area have a more theoretical basis, and a new quantitative approach is highly recommended for future research (Franco and Haase 2015; Lopes and Lussuamo 2020), even in the most developing countries. Evidence shows that this kind of cooperation brings great advantages, but it is important to understand which obstacles and challenges must be overcome if we want to prevent cooperation failure. Barriers such as the size of the company (Azagra-Caro et al. 2006; Cristo-Andrade and Franco 2019), lack of tradition (Azagra-Caro et al. 2006), cultural differences (López-Martínez et al. 1994), bureaucracy, researchers' accountability (Franco and Haase 2015) and scientific risks (Ramos-Vielba et al. 2016) were reported to be factors that may inhibit U–I cooperation.

In the second line of research, it was possible to identify which R&D determinants influence cooperation. The following aspects were mentioned: the sector of activity (Veugelers and Cassiman 2005), the size of the company (Fernández-López et al. 2019; Gallego et al. 2013; Rõigas et al. 2018; Szücs 2018; Veugelers and Cassiman 2005), R&D intensity (Lhuillery and Pfister 2009), the search for knowledge (Gallego et al. 2013), being part of a corporate group (Iammarino et al. 2012), international openness (Iammarino et al. 2012; Rõigas et al. 2018) and the founder's characteristics (Nishimura and Okamuro 2011). Although many determinants have already been analyzed, further research should identify other determinants that can adequately explain the effect of cooperation as a complementary innovation strategy (Veugelers and Cassiman 2005).

Although previous studies have already stressed the importance of cooperation in various sectors of activity, it is of utmost importance to understand how cooperation has evolved over time. That way, future research will have to conduct studies involving companies from different sectors and countries to provide more comprehensive data and research should be conducted using longitudinal data (Badillo et al. 2017; Fernández-López et al. 2019; Gallego et al. 2013). On the other hand, future studies will need to refine the measurement of absorption capacity and calculate variables that take into account the time lag between entrances and exits for each specific service area (Choi and Choi 2020).

Another result obtained from the review of the literature is that the success of a R&D project depends heavily on the number of participants. Thus, researchers should explore the nature of spillover repercussions and geographical proximity for R&D cooperation (Szücs 2018). One of the reasons for companies to engage in cooperation agreements with universities is that the collaboration between them allows scientific progress to be diffused more quickly and improves company performance. It would then be interesting for future research to add company performance indicators to the model to study the relationship between companies' success and their cooperation with universities (Rõigas et al. 2018).

However, since motivations and barriers depend on the type of partner organization involved, motivations may help overcome perceived barriers, increasing the likelihood of cooperation. This suggests that possible future investigations should analyze whether or not "cognitive proximity" between partners increases the likelihood of motivations overcoming risk perceptions in cooperation decisions (Ramos-Vielba et al. 2016).

The third line of research, highlighted by most of the literature, is related to government policies. It is a fact that if those policies are not focused on cooperation, they could represent a major obstacle to collaboration liaisons. Thus, future research should conduct international comparative studies to generalize the mediating effects of U–I cooperation performance and suggest how government funding in R&D should be directed (Stejskal et al. 2016; Suh et al. 2019; Zeng et al. 2010).

Another aspect to be mentioned is the inter-organizational relationships that is extremely important to innovation and competitiveness. That way, future studies should conduct international comparative research (on and off-site and at different sectoral boundaries) (Miozzo and Dewick 2004). Other future research based on

this topic should aim at identifying the causality between R&D cooperation with scientific institutions and firms' innovation performance (Pippel and Seefeld 2015). On the other hand, future studies may resort to the application of the 4 W questions method, through a more developed logic and methodology (other than through

Table 8 Suggestions for future lines of research

Cluster/topic	Suggestions for future research
Motivations and barriers to cooperation	To carry out studies on motivation in cooperation based on quantitative approaches To analyze whether or not the "cognitive proximity" between partners increases the likelihood of motivation to overcome risk perceptions in cooperation decisions To analyze the motivations of companies that lead to future cooperation based on an analysis according to the size of the company Conducting quantitative studies on the identification of barriers that hinder U–I cooperation in developing countries
Determinant factors	To identify other determinants that may adequately explain the effect of cooperation as a complementary innovation strategy To carry out studies involving companies from different sectors and countries but using longitudinal data To explore the nature of spillover effects and geographical proximity for R&D cooperation To add company performance indicators to the model to study the relationship between the firms' success and their cooperation with universities Need to refine the measurement of absorption capacity and calculate variables that take into account the time lag between entrances and exits for each specific service area
Government measures	To carry out international comparative studies to generalize the mediating effects of U–I cooperation performance and suggest how government funding in R&D should be directed To design an international comparative analysis (on and off-site and at different sector boundaries) of inter-organizational relationships To identify the causality relation between R&D cooperation with scientific institutions and firms' innovation performance To apply and test the 4 W methodology in other technology domains or import data from other countries around the world
Intersector Technology Cooperation	To explore the commercialization phenomenon as a manifestation of the intersection of variables in both cooperating sectors To identify factors (barriers and facilitators) that are impacted by the infrastructure dimensions that will influence sustained performance Analysis the commercialization oriented to market demand is necessary to reinforce professionalism Explore the role of geographical proximity of participants in mediation gains from research subsidies

manual technique), in other fields of technology or import data from other countries around the world (Ran et al. 2020).

The last line of research addresses Intersector Technology Cooperation, namely the cooperation established between universities, industry and government, which is seen as feasible, and may produce results that benefit all parties, but is also quite complex. Therefore, said cooperation will only persist as long as the parties involved are willing to. Future research should explore the role of geographical proximity of participants in mediation gains from research subsidies (Szücs 2018). On the other hand, future research should explore the phenomenon of commercialization as a manifestation of the intersection of variables in both cooperating sectors (Geisler and Turchetti 2015; Suh et al. 2019). Another interesting future research analysis will address the identification of factors (barriers and facilitators) that are impacted by the infrastructure dimensions that will in turn influence sustained performance (Geisler 2003).

Table 8 summarizes the future lines of research for each of the clusters.

5 Conclusions

This article was based on a systematic review of the literature addressing U–I cooperation. Through a bibliometric analysis, 4 clusters were identified: (1) motivations and barriers to cooperation, (2) determinant factors, (3) government measures and (4) intersector technology cooperation.

It was established that U–I cooperation plays an increasingly important role, not only for cooperation partners themselves, but also for governments, policymakers, researchers, professionals, and that the success of any cooperation agreement will serve the best interest of all parties involved. Although the advantages of said cooperation are fully acknowledged, some barriers and obstacles can cause their failure. On the other hand, some determinants and motivations may generate successful cooperation liaisons. Thus, governments will play a crucial role in making cooperation possible and auspicious to all parties involved. A model has then been suggested that will hopefully stand as a contribution for future research studies addressing the issue. However, the systematic review of the literature conducted makes it possible to realize the need for further studies covering the issue of U–I cooperation, as there is still so much to investigate. In order to contribute to the development of the literature on this topic, it would be interesting for future research to broaden the scope of the investigation, namely by including articles indexed to other databases and applying other bibliometric techniques. Additionally, as evidenced in the research and in the developed conceptual model, the importance that the government has when cooperating is known, however it would be interesting, since these three actors are inserted in a specific society, conducting studies, even comparative ones, that to allow analysis of what influence they have during cooperation—quadruple helix.

This article, like all research studies, has its limitations that may open the way for new researches. One of its limitations is the fact that it used a single database to collect the data. Besides, the selection process that guided the selection of the literature

involved some limitations, namely the choice of keywords (for example, broader research would have possible if we had used a keyword like "higher education").

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