

# International Knowledge Transfer from University to Industry: A Systematic Literature Review

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## Abstract

International knowledge transfer contributes to the competitiveness of enterprises and regions, to the ranking of universities, and to solving common global problems. Based on a systematic literature review, the main purpose of the current study is to explore the channels, motivations, activities and outcomes, and influencing factors of university to industry international knowledge transfer (U-I IKT), and understand how the concept is related to the internationalisation of R&D, innovation systems and higher education. The paper contributes to the existing body of knowledge by creating an integrated framework for understanding U-I IKT. It proposes that U-I IKT can be conceptualised on the basis of two dimensions – on the one hand, as an activity that has distinct channels, motivations, activities and outcomes, and influencing factors. On the other hand, U-I IKT can be seen as a stream of research on its own right, albeit overlapping with other areas of the internationalisation of knowledge transfer, namely the internationalisation of innovation systems, firm R&D activities and higher education institutions.

JEL classification codes: O30

Keywords: international knowledge transfer, university-industry collaboration, cross border, institutional distance

# 1. Introduction

International knowledge transfer can be seen as a multi-faceted phenomenon. It has become one of the key elements for addressing global problems related to the environment, health, security and economic development. In order to manage these issues, most countries have adopted a number of policies and programmes to promote the international transfer of knowledge and technology. In addition, multi-national corporations (MNCs) have resorted to the internationalisation of their research and development (R&D) for the acquisition of new knowledge from different sources to withstand global competition (Kauppinen, 2012). Consequently, universities are seen as the main producers of ‘new knowledge’, which contributes to the development, innovation and competitiveness of companies, regions and countries (D’Este and Perkmann, 2011; Huggins et al., 2008; Huggins et al., 2012). Although the engagement of universities with industry has a long tradition, with the need to address global problems, the surge of new policy incentives, the improved regulatory environment and the changing funding base of universities, the number of studies on university-industry relations has increased vastly during the last decade (Perkmann et al., 2013).

Researchers have frequently attempted to synthesize the literature on activities and actors characterizing knowledge transfer (KT) from university to industry (Agrawal, 2001; Perkmann and Walsh, 2007; Rothaermel et al., 2007; Yusof and Jain, 2010; Wahab et al., 2012; Perkmann et al., 2013; Bozeman et al., 2013; Ankrah and Al-Tabbaa, 2015). These reviews have often focused on only one or two aspects of university-industry linkages, for instance, identifying firm/university characteristics, geography of interactions and channels (Agrawal, 2001), developing a taxonomy of university entrepreneurship (Rothaermel et al., 2007; Yusof and Jain, 2010), technology transfer (Wahab et al., 2012), addressing academic engagement antecedents and consequences (Perkmann et al., 2013). In a more comprehensive review paper, Ankrah and Al-Tabbaa (2015) have synthesized the literature on KT under the broad themes of KT processes such as forms, motivations, formation and activities, enablers and inhibitors, and outcomes. However, none of these reviews has focused specifically on the university to industry international knowledge transfer (U-I IKT).

Furthermore, studies on the international dimensions of KT cover a wide range of different streams of research like the internationalisation of university-industry or university-industry-government cooperation (Caloghirou et al., 2001; Tijssen et al., 2009; Shin et al., 2012), the internationalisation of firm R&D (Davis and Meyer, 2004; Dunning and Lundan, 2009; Krishna et al., 2012; Liang et al., 2015), the internationalisation of higher education (Warwick, 2014; Kosmützky and Putty, 2015) and the internationalisation of innovation systems (Carlsson, 2006). These studies have focused mostly on either MNCs, higher education institutions or government as the central actor, but few have explored the interplay between different types of actors located across national boundaries. There is, therefore, a need to understand what is unique about U-I IKT and how it overlaps with other approaches to the internationalisation of KT.

The paper aims to fill these gaps by constructing a framework for understanding university-industry international knowledge transfer. This is achieved by synthesizing the existing literature in order to answer the following research questions: (i) *Are there specific channels, motivations, activities and outcomes, and influencing factors that characterize university-industry international knowledge transfer, and* (ii) *How does the concept of university-industry international knowledge transfer relate to the internationalisation of R&D, innovation systems and higher education.*

The current paper addresses KT for either academic engagement or commercialisation purposes at the inter-organizational level mainly between individuals who originate from different types of organizations (universities and enterprises, and in some cases universities, enterprises and government), which are situated in different countries. KT from university to industry is understood as comprising academic engagement or knowledge focused research collaborations, and commercial engagement or property focused collaborations (Perkmann et al., 2013; Bozeman et al., 2013). The former activity is pursued for various objectives like expanding the base of knowledge and enhancing the reputation and careers of academics (e.g. collaborative research, contract research, consulting, informal networking), while the latter intends to exploit an academic invention with the objective of financial gain (e.g. patenting, licensing, creating spin-offs).

The paper contributes to the existing body of knowledge by creating an integrated framework for understanding U-I IKT. It proposes that U-I IKT can be conceptualised, on the one hand, as an activity that has distinct channels, motivations, activities and outcomes, and influencing factors, and on the other hand, as a stream of research in its own right that overlaps with other areas of the internationalisation of KT, namely the internationalisation of innovation systems, firm R&D activities and higher education institutions.

The remaining part of the paper is organized as follows. The next section discusses the theoretical issues related to studies of university-industry linkages to construct a conceptual framework to analyze IKT in the context of university-industry collaborations. The subsequent section deals with the methodology adopted for the study. The fourth section presents and discusses the findings of studies on U-I IKT and emerging issues. The last section provides the conclusions, the theoretical contribution of the paper and scope for further research.

## 2. Overview of main concepts

### 2.1. University to industry international knowledge transfer

The term knowledge transfer itself is ambiguous (Lockett et al., 2009), as it is used synonymously with a range of related terms, such as 'knowledge dialogue' (Ruddle, 2000), 'knowledge exchange' (Schartinger et al., 2002; Swart and Henneberg, 2007) and 'knowledge translation' (Czarniawska and Sevón, 1996; Savory, 2006). KT between university and enterprises can be seen as a process characterized by multiple channels, motivations, activities and outcomes, and influencing factors (Duan et al., 2010; Ankrah and Al-Tabbaa, 2015). International university to industry KT shares many characteristics with university to industry KT in general.

KT channels can be understood as ways for the transfer of knowledge. University-industry KT consists, on the one hand, of academic engagement or knowledge focused research collaborations, and, on the other hand, of commercial engagement or property focused collaborations (Perkmann et al., 2013; Bozeman et al., 2013). Academic engagement comprises mainly collaborative research, contract research, consulting, informal networking, while commercialisation involves patenting, licensing, creating spin-offs. Some channels are more suitable for certain types of knowledge to be transferred. Explicit knowledge means published research findings, which are codified, formulated and available; but in addition, there is tacit knowledge related to skills and experiences that can only be obtained by face-to-face contact

(Karnani, 2012). Activities that allow more immediate communication like internships, joint supervision, secondments, collaborative research and the creation of joint ventures are the most suitable for transferring tacit knowledge, while less media-rich activities like shared facilities and licensing patents consist of the transfer of explicit knowledge (Alexander & Childe 2013).

Actors have different motivations for why they engage in KT activities. Siegel et al. (2003) distinguish in addition to enterprises between various actors within the university, such as academics and technology transfer specialists. The actors have partly conflicting motives and organizational cultures that influence their participation in KT. Dutrénit and Arza (2010) distinguish in the case of enterprises between firm's benefits related to short-term production activities and long-term innovation strategies. Furthermore, nation states have their competitive interests, which could lead to technology-nationalism (Ponds, 2009). Different motives lead to different channels being used as academic engagement is undertaken mainly for expanding the base of knowledge and enhancing the reputation and careers of academics, while commercialisation intends to exploit an academic invention with the objective of financial gain (Perkmann et al., 2013).

Activities and outcomes relate to steps in the process of forming university-industry cooperation, and the benefits that are obtained. The number of stages from the identification of partners to signing an agreement that the formation of collaboration undergoes has been found to depend on its degree of formality and complexity (Ankrah & Al-Tabbaa, 2015). KT can involve relying on an existing network of contacts or intentionally seeking new external sources of knowledge. Studies on trajectory and intentional networks have found that previous interactions contribute to the formation of strong trusting relationships for accessing knowledge, while newer connections tend to be weaker and more formalised (Sousa & Fontes 2014). The benefits that KT leads to can be economic, institutional or social (Ankrah and Al-Tabbaa, 2015). But not all outcomes are positive as collaboration can lead to exploitation, negative impacts on students and unethical behaviour (Bozeman et al., 2013).

Influencing factors are those that either facilitate or inhibit KT. Actors are organized in networks of nodes (individuals or organizations) connected through more or less structured relationships (Granovetter, 1973; Krackhardt, 1992). The distance between various actors has several dimensions – cognitive, organizational, social, institutional and geographical (Boschma, 2005). Too much proximity has been found to be harmful, as excessive cognitive proximity (similarity in technological knowledge) reduces the possibility for novelty and learning, so partners should be rather located at an optimal cognitive distance to retain both mutual understanding and novelty (Nooiteboom et al., 2007). Petruzzelli (2008) has concluded that high geographic, organizational and technological closeness is characteristic of developing joint intellectual property, while joint research projects require a more distant knowledge base.

While similarities in the content, channels and actors involved in the KT process can be found between international KT and KT in general, the differences in the institutional contexts the actors originate from add a unique dimension to U-I IKT studies. For example, Malik (2013), drawing on the analysis of international collaborations of 256 biotechnology companies found that whilst distance in terms of level of industrial development appear to negatively affect the transfer of university-generated knowledge across national boundaries, distance in religious, social, and educational institutions has a positive effect. IKT is also characterized by a lack of geographical proximity, in which case the absence of spatial proximity can be substituted by some forms of non-spatial proximity. In this vein, Hansen (2015) has found that

there is evidence of geographical proximity being replaced by cognitive, organizational and social proximity. Furthermore, temporary geographical proximity in the form of short visits can contribute to overcoming the problems created by distance (Knoben & Oerlemans, 2006), and the transfer of tacit knowledge between geographically distant partners.

In the current study, U-I IKT is understood as KT for either academic engagement or commercialisation purposes at the inter-organizational level mainly between individuals who originate from different types of organizations (universities and enterprises, and in some cases universities, enterprises and government) situated in different countries.

U-I IKT is seen as a two-dimensional concept. Firstly, it is characterized by specific channels, motivations, activities and outcomes, and influencing factors that form the building blocks of the university-industry collaboration process. These are partly similar to KT carried out within national boundaries, but there are also specific issues like national interests and technology protectionism, lack of geographical proximity, differing political, regulatory (incl. intellectual property protection), social and economic environments, and the importance of inter-governmental organizations like the EU and WTO. Secondly, U-I IKT has similar traits with other streams of research looking at the internationalisation of KT, namely the internationalisation of innovation systems, firm R&D activities and higher education institutions. U-I IKT is a wider field than these, as by definition it involves the interactions of different types of actors. At the same time, some internationalisation activities of higher education institutions may only involve university-to-university cooperation, firms participating in knowledge networks consisting only of other firms that are part of their supply chain, and government bodies cooperating with other government bodies across national borders.

## 2.2. Internationalisation of innovation systems

Carlsson (2006), in his comprehensive review of literature on Internationalisation of Innovation Systems (IIS) (national, regional, sectoral and technological), found only five studies dealing explicitly with the internationalisation aspects of innovation systems (Niosi and Bellon, 1994, 1996; Bartholomew, 1997; Fransman, 1999; Niosi et al., 2000). Niosi and Bellon (1996) showed that although national innovation systems are becoming more intertwined globally, the local and national networks are still important. Bartholomew (1997) studied the biotechnology sector in four developed countries (USA, UK, Germany and Japan) and found that 'tapping into foreign innovation systems through international cooperative alliances gives firms access to a wider range of solutions to technological problems' (p. 262). Fransman (1999) studied the degree of the internationalisation of the Japanese innovation system and found that even though Japan still lags behind other countries in terms of the internationalisation of its science and technology system, the degree of internationalisation has increased significantly over the last decades.

All these studies have indicated the increasing interdependence of innovation systems in different countries. At the same time, some scholars have noted the emergence of technoglobalism and argued that the role of the regional and national system of innovation could become less influential (Ohmae, 1990; Reich, 1991) and more internationalised. However, the later studies have shown that national policies and institutions still play a crucial role. Such studies can be said to address techno-regionalism/nationalism, and analyze how regional or national innovation systems facilitate the firms' activities and how different organizations

jointly create, diffuse and use knowledge in the region and nation (Lundvall, 1992; Nelson, 1993). However, there is no consensus among scholars on whether internationalisation has undermined the national /regional innovation systems or has strengthened them.

Therefore, the IIS focuses on ensuring the competitiveness of a country through cooperation and competition with other actors. While the central actor is government, enterprises and universities also play an important role here as part of the overall network.

### 2.3. Internationalisation of firm R&D

IKT between firms and its impact on the innovation performance of firms has been extensively studied (Marcon, 2012; Easterby-Smith et al., 2008). Most of these studies on Internationalisation of R&D (IR&D) are concerned with intra- or inter-firm transfer of knowledge across national boundaries, the co-evolution of a firm's knowledge base and external foreign sources of knowledge (Chuang, 2014). Scholars have also focused their analysis on how cultural, language/ institutional congruence between the headquarters and subsidiaries facilitates the smooth operations of the firm and the implementation of human resource management practices (Choi and Johanson, 2012; Simona and Axele, 2012; Welch and Welch, 2008). Some scholars have shown that collaboration with foreign firms contributes to the knowledge base of local firms and enhances their performance. In recent years, a few scholars have also focused their attention on the role of ICT in U-I IKT (Wu and Lee, 2012) and have argued that information technology can improve the quality and quantity of information exchange and have a positive influence on cross-border transfer of knowledge. However, IKT has been found to have some positive effects only in the case of a 'low context communication culture' and there is very little impact on KT in a 'high context communication culture' and on vertical and lateral linkages among different organizations (ibid.).

The general assumption of these studies is that KT between organizations takes place without a loss, which seems a faulty assumption. To overcome these problems, the concept of 'knowledge translation' has been developed, which takes into account the modification of knowledge when transferring from an MNE's headquarters (host country) to its foreign subsidiaries (Choi and Johanson, 2012). There are, furthermore, studies that have emphasized the limitations of applying a standardized and universal set of KT mechanisms without considering the local idiosyncrasies and the importance of local agents and institutions throughout the process of local knowledge adaptation (Hong and Nguyen, 2009). There is an emerging consensus that internationalisation raises a firm's tendency to innovate in terms of product development, R&D spending and patenting (Boermans and Roelfsema, 2015).

IR&D is concerned mostly with achieving global competitiveness on new markets for firms through competition. The central actors are MNCs or enterprises that establish partnerships with other enterprises, but also public research organizations in the host country diversifying their resources.

### 2.4. Internationalisation of higher education

Most of the studies dealing with the internationalisation of HEIs have generally focused on academic exchange, collaborative research networks, co-authorship and transnational career paths (Wong et al., 2007; Garrett-Jones and Turpin, 2012). Some scholars have also noted that the basic motive of universities approaching foreign firms is to gain/mobilise research funds.

For instance, Howells (1990) noted the increase in industry-university linkages on a transnational basis during the 1980s and highlighted the increasing involvement of Japanese companies with US higher education institutions. The internationalisation of university research systems was also noticed in the UK where research grants and contract income received by higher educational institutions from overseas, also including foreign firms, increased by 11.7% between 1995–96 and 1996–1997 (Howells and Nedevea, 2003).

This phenomenon has been called ‘transnational academic capitalism’, which refers to the integration of the transnational dimension in teaching, research and services in a way that enhances transnational integration between universities and globalising knowledge capitalism, and increases the opportunities for academics and universities to diversify their external funding sources transnationally (Kauppinen, 2012). In this way, higher education is integrating with transnationally mobile capital, and especially with those transnational corporations that are heavily involved in knowledge-intensive transnational economic practices. This has also led to the emergence of a specific route of internationalisation, which MNCs called ‘collaborative doctoral education in university-industry partnership’ (Borrell-Damian et al., 2010).

Some studies have, however, pointed out that an over emphasis on international collaboration in academia (e.g. joint academic publications) has not only weakened the domestic/national university-industry interactions but has also weakened the status of universities in the national innovation system (Howells, 1990). Therefore, the Internationalisation of Higher Education (IHE) is seen, on the one hand, as something positive and important, as almost all higher education institutions refer to their international dimension in mission statements and in the formulation of their profiles. On the other hand, internationalisation is considered a reflection of the existing international inequality between nations and world regions because about three-quarters of the world’s mobility is vertical (Kehm and Teichler, 2007).

IHE relates mostly to enhancing the quality of education and mobilising the resources of HEIs. The central actors are universities and research organisations that establish partnerships with other universities, but also enterprises and government actors in foreign countries.

In conclusion, the internationalisation of the activities of countries, enterprises and universities has been studied under different streams such as internationalisation of R&D (IR&D) (Easterby-Smith et al., 2008; Marcon, 2012; Krishna et al., 2012), internationalisation of innovation systems (IIS) (Carlsson, 2006) and internationalisation of higher education (IHE) (Warwick, 2014; Kosmützky and Putty, 2015). These studies deal with the transfer of knowledge across national boundaries and underline motivating and inhibiting factors, different channels of KT and the outcomes of KT. The issues related to the transfer of knowledge overlap in the case of the different streams of literature, but they also possess their own motives and perspectives. While sharing the trans-boundary aspects of KT, IIS focuses on the cross-border activities of innovation systems facilitated by governments, IR&D looks at the internationalisation of firms and IHE centres on universities. U-I IKT can be seen both as an overlapping and separate stream of literature with elements similar to other areas of the internationalisation of KT as well as having its own specific features.

### 3. Methodology

In order to conduct a systematic literature review, the principles outlined by Tranfield et al. (2003) were followed in order to synthesize the studies on IKT between universities and industry. A systematic literature review was undertaken to facilitate answering a clearly formulated question by finding, describing and evaluating evidence from all published studies on topic(s) related to that question within a specific set of boundaries (Eriksson, 2013). A systematic review is different from the traditional literature review in which there is often no attempt to seek a generalisation or cumulative knowledge of what is reviewed, and such reviews are considered opportunistic, selective, haphazard, lacking a systematic and exhaustive search of all the relevant literature (Davies, 2000).

The objective of the current study was to establish what is known about the U-I IKT, particularly in the context of university-industry linkages. This objective was influenced by the observation that there is a considerable amount of literature on the issues related to the cross-border transfer of knowledge, but these studies are scattered under different themes such as IR&D, IIS and IHE focusing on the specific perspective of firms, government and higher education institutions, respectively. Therefore, a systematic review of the literature was deemed necessary to assess the current knowledge and collate the scattered findings and present them in a way that may provide collective insights and guidance in meeting the needs of policy makers, academics and managers involved in the cross-border transfer of knowledge.

Guided by these objectives, the following procedure was applied. First, all relevant studies published on this topic from 1970 to 2015 were identified using a variety of keywords and their combinations that related to U-I IKT and university-industry collaboration. The search was confined to two databases: Scopus and Web of Science, as these datasets abstract and index peer reviewed high-quality research. The keyword search covering of the terms “university industry”, “international”, “collaboration” and their synonyms<sup>1</sup> produced a total of 423 articles (241 articles from Scopus and 182 from Web of Science). Only research articles published in the English language were included in the study. After deleting duplicates, we were left with 208 articles. Subsequently, the title, abstract and if necessary the whole text was carefully read, and in the end 82 articles remained. Both authors read the text of each article using the following criteria for deciding whether to include it in the study:

- Does the study address the issues of KT between universities and enterprises (and sometimes government) that are located in different countries?
- Does the study address research related activities of university-generated knowledge (rather than educational activities)?
- Does the study address U-I IKT as a central issue?

By applying these criteria, we were able to identify 22 studies that addressed IKT between universities and industry. We further used the snowballing technique and looked through the references of the selected articles to find other relevant studies. This rendered the final article

<sup>1</sup> The following keyword combinations were used in the literature search: “international” OR “transnational” OR “cross border” OR “cross national” AND “knowledge transfer”; “international university industry collaboration”; “university industry” AND “international collaboration” OR “international relations” OR “international linkages” OR “international cooperation” OR “international research” OR “international technology transfer” OR “international” OR “proximity”.



count of 26 articles, which we read and synthesized by compiling the following information for each study in a tabular form: author and publication year, research questions, source of data, methodology, variables used and findings.

The articles that were selected for the analyses have been published between 2001 and 2015. The main outlets of these studies are: Journal of Technology Transfer (3 instances), Research Policy (3 instances), Scientometrics (2 instances) and Papers in Regional Science (2 instances). Only one article was published in each of the following journals: Economics of Innovation and New Technology, Environment and Planning A, European Journal of Innovation Management, FEP Economics and Management, Globalization, Societies and Education, IEEE Transactions on Engineering Management, Information and Management, International Journal of Technology Management, Journal of Business and Industrial Marketing, Journal of Knowledge-based Innovation in China, Journal of the American Society for Information Science and Technology, Journal of the Association for Information Science and Technology, Journal of the Korea Academia-Industrial Cooperation Society, Research Evaluation, and Annals of Regional Science.

However, the paper is not without limitations. The paper addresses KT for either academic engagement or commercialisation purposes at inter-organizational level mainly between individuals who originate from different types of organizations (universities and enterprises, and in some cases universities, enterprises and government), which are situated in different countries. This means the study comprises partly organizational and partly individual level analysis, as individuals that cooperate do so in their organizational contexts. The study largely leaves aside research partnerships purely at the organizational level (e.g. Hagedoorn et al., 2000) and person-to-person interactions inside research groups (e.g. Hautala, 2011). This also means that the study looks at collaborations between different types of organizations, and does not cover university-to-university, firm-to-firm or government-to-government KT across national borders. In addition, the meta-analysis of previous research is confined to English language articles in two databases (Scopus, Web of Science), which covers only a part of the research published on the topic, as it excludes other languages and other types of publications. This was a necessary limitation in order to render the number of studies found using the keyword search manageable.

## 4. Results

### 4.1. Channels, motivations, activities and outcomes, and influencing factors of international knowledge transfer

#### 4.1.1. Channels of international knowledge transfer

Certain channels or methods of cooperation are more suitable for either explicit or tacit knowledge to be transferred. In the case of the international transfer of knowledge, it has been observed that interactions with non-local universities generally include the transfer of codified forms of knowledge, while links with local universities include more tacit forms of knowledge (de Fuentes and Dutrénit, 2014) as it is difficult to transfer tacit knowledge without regular face-to-face contact. Breschi and Lissoni (2001) argue (drawing on Mansfield (1995)) that when local universities are not able to produce the basic research needed by enterprises, they turn to top universities, leaving local collaboration more for buying applied R&D services accompanied

also by more frequent face-to-face interaction. International activities have also been observed in co-incubation in which case start-up businesses are assisted to enter other national markets or benefit from specialised services when scientific, technological and commercial knowledge is absent in the home country but present in a partner country (Cooke et al., 2006).

Therefore, in addition to the explicit and tacit nature of knowledge, proximity is also important in terms of the division between 'basic research' and more 'applied R&D' services and market-oriented activities. In that vein, universities tend to favour larger and longer-term collaborative research projects because of the more basic nature of the research (Caloghirou et al., 2001). Close geographical proximity has been found to contribute to learning, trust, close and continuous interaction in short-term applied projects; while in the case of long-term projects, it is easier to work across geographical distances (Broström, 2010). Along similar lines, firms seeking business advice are more likely to collaborate with regional universities while firms seeking R&D support and testing and analysis services are more likely to collaborate with both regional and non-regional universities (Maria et al., 2014). At the same time, foreign investors are likely to choose local universities over local firms when the alliance has been established primarily for research rather than development purposes (Li, 2010).

#### 4.1.2. Motivations for engaging in international knowledge transfer

In terms of research organizations, in addition to the local and regional role, universities also function at the international level and have to consolidate these different functions (Fromhold-Eisebith and Werker, 2013; Howells and Nedeva, 2003). It has been found that the quality of academic research and geographical distance are related in that higher performance research groups are more interested in cooperating with distant firms (Garcia et al., 2014), as international collaborations have higher citation impact than national and regional collaborations (Frenken et al., 2010).

Enterprises, on the other hand, are mainly interested in the financial gain, and secondly, in maintaining control over their technologies (Siegel et al., 2003). In terms of international collaboration, studies have shown that firms with higher levels of absorptive capacity tend to form more geographically distant links with universities (de Fuentes and Dutrénit, 2014), valuing, at the same time, the research quality of the university partner more than its geographical proximity (Laursen et al., 2011). Under the conditions of transnational academic capitalism, MNCs play an important role in interacting globally with universities (Kauppinen, 2012), and a number of studies have focused on alliances between MNCs and universities (Belderbos et al., 2014; Sorensen and Hu, 2014; Li, 2010). Studies have noted that MNCs resort to collaborating with local universities to take advantage of the host country's scientific and technological inputs, expand their capabilities, obtain complementary technologies or skills, achieve economies of scale in R&D, and better monitor the behaviour of their local and international competitors (Gassmann and Han, 2004), and to avoid the loss of information to competitors (Caloghirou et al., 2001). The SMEs, on the other hand, have been found to collaborate internationally more often as part of their supplier-customer relationships rather than with R&D organizations, which highlights the importance of organizationally close collaborates (de Zubielqui et al., 2015).

Different countries have different interests for IKT. In some 'R&D markets' like the USA and Japan, which are vast and highly developed in terms of local science-dependent industry, it is possible for a large proportion of university-industry interactions to take place domestically (Tijssen et al., 2009). Unlike most English-speaking and South-Asian countries that have

focused on increasing their share of the international market of higher education teaching services, France seems much more interested in developing a competitive R&D in the university-industry sector (Vinokur, 2010). It has also been found that in more economically developed English-speaking countries, the university sector plays a key role in international university-industry-government collaborations; while, in less-wealthy non-English-speaking countries it is the government that has this key role (Choi et al., 2015).

#### 4.1.3. Activities in and outcomes of international knowledge transfer

There are several processes specific only to transferring university knowledge to industries across national boundaries. Jin et al. (2011) have distinguished between direct and indirect processes of U-I IKT between university and industry. Direct cooperation occurs between domestic universities and foreign companies, or between domestic companies and foreign universities. Indirect KT involves the local branches of MNCs as intermediaries between a domestic university and a foreign enterprise (headquarters of an MNC) or university. In addition, it is possible that indirect cooperation is also mediated by universities not only by enterprises. This would mean that it is the universities in different countries that primarily interact with each other and involve also local enterprises in this kind of cooperation.

Another perspective is embodied in studies that use the concept of a triple helix. Therefore, Sorensen and Hu (2014) have shown through a process view how the triple helix becomes internationalised through merging with the respective structure in another country. It was found that this process occurs in several stages: pioneering, exploration, and integration. In the pioneering stage, the authors see the establishment of each of the three spheres of the helix abroad – the internationalisation of companies, universities and governments; in the exploration stage, the three spheres start to interact abroad and collaborate with their counterparts in the host country; in the integration stage, helix-to-helix collaboration emerges.

The outcomes from engaging in international university-industry relations are complicated to assess. Several studies have compared the university-industry-government co-authorship relations nationally and internationally. Leydesdorff and Sun (2009) have found that the Canadian publication system is more internationalised than the Japanese, but national triple helix relations are much stronger in the Japanese system, as the former is better integrated with the Anglo-Saxon system. Kwon et al. (2012) have observed in the case of South Korea that the triple helix has eroded at the national level with increased internationalisation (as was previously found in Japan), but strengthening the national system is vital because of regional disparities in the ability to cooperate internationally. In Saudi Arabia, it was found that the triple helix collaboration does not differ between domestic and international collaborations, although there has been a rapid increase in international collaborations (Shin et al., 2012).

Bringing together the domestic and international level may prove problematic as international university-industry KT has been found to have negative outcomes. There are fears of domestically funded academic research leaking to foreign firms leading to technologicalism in research policy (Ponds, 2009). In addition, next to the caveats that more intensive university-industry collaboration is likely to decrease public control over university research and increase industry's influence resulting in more applied research, shorter research time and delays in publication, the internationalisation of research may leave the needs of smaller domestic firms (SMEs) inadequately addressed (Howells and Nedeva, 2003).

#### 4.1.4. Influencing factors of international knowledge transfer

Geographical distance seems to foster more collaboration between similar types of organizations (e.g. between universities or between enterprises) because of institutional proximity, whereas collaboration between different kinds of organizations (e.g. university and industry) is more spatially confined (Ponds et al., 2007; Ponds, 2009). There are conflicting findings as to how geographical distance can be compensated. Although absorptive capacity has been found to increase cognitive proximity between partners, even if they are geographically distant (Jong and Freel, 2010), Araújo and Teixeira (2014) reported, based on 71 technological partnership agreements, that human capital and absorptive capacity are negatively associated with international technology transfer.

Different types of enterprises have varying abilities to overcome the difficulties created by the lack of geographic and other forms of proximity when cooperating internationally with universities. Geographic proximity has been found to be less important with the increase in the firm's R&D expenditure, activity in the North-American market and the importance of codified basic research results, while the quality and output of domestic public research organizations and the importance given to public science by the respondents increases the importance of proximity (Arundel and Geuna, 2004). Fransman (2008) has distinguished between large national and international R&D intensive firms, university spin-offs and SMEs concluding that the costs are highest for SMEs with little previous cooperation experience with universities. Similarly, Freel (2003) has found in the case of 597 manufacturing SMEs in the UK that the spatial distribution of firm linkages is positively affected by firm size, export propensity and the introduction of novel (radical) innovations. Belderbos et al. (2014) have also reported that MNCs with high capacity for R&D find a region lucrative based on its academic strength, including the supply of PhD graduates.

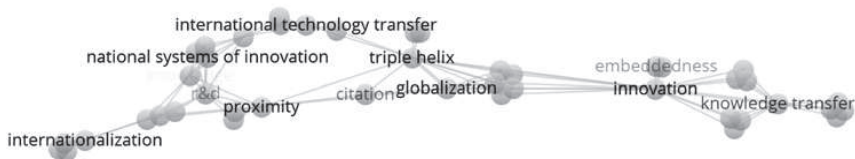
Existing studies emphasize the role of institutional proximity for the transfer of knowledge across national boundaries. Hwang (2010) discussed the interplay between organizational and national cultures and concluded that national barriers operate within an organizational system and long-term cooperation is needed to overcome those. Other studies have also confirmed that institutional differences affect KT across national boundaries, but different elements of institutions affect KT differently. For instance, Malik (2013) studied the interaction of 256 biotechnology firms from 24 countries and their sourcing of technology (measured in terms of licensing of patents) from universities located in 31 countries, and found that some elements of institutions (religious, social and educational distance) influence international technology transfer positively, while some elements (level of industrial development) influence it negatively, and yet some other elements of institutions (political distance) have no influence.

#### 4.2. Connections between the internationalisation of knowledge transfer, innovation systems, higher education and R&D

U-I IKT is a wide area of activity that is a domain in its own right, and at the same time, also partly overlaps with other domains like the internationalisation of innovation systems, higher education institutions and enterprise R&D activities. In order to understand the inter-connections between different concepts used in U-I IKT studies, a bibliographic network of author keywords was produced with the help of the VOSviewer software. VOSviewer makes it possible to graphically represent bibliometric maps using among other means keywords from

articles based on co-occurrence data (van Eck and Waltman, 2010). Data from Web of Science and Scopus was used to construct a network of 69 author keywords from U-I IKT papers, and a graph representing bibliographic connections was produced that illustrates the entire network of concepts and their sub-groups. Analysis of the keywords from articles rendered four sub-groups of concepts (Figure 1). It was found that two sub-groups consist of firm R&D, national systems of innovation and university-industry-government cooperation, while another two cover higher education institutions and external linkages (SMEs, incubators).

Figure 1. Map of author key words from U-I IKT studies



Source: Compiled by the authors

KT across national boundaries is partly related to other areas such as IIS, IR&D and IHE. Based on the different concepts found in U-I IKT studies, a framework depicting the objectives, nature of activities, dominant actors, theoretical framework and policy implications of U-I IKT studies was developed, including the characteristics of U-I IKT and also similarities and differences with IIS, IR&D and IHE (Table 1).

Table 1. Linkages between the internationalisation of knowledge transfer, R&D, innovation systems and higher education

Parameters	Internationalisation of knowl- edge transfer (U-I IKT)	Internationalisation of R&D (IR&D)	Internationalisation of innovation sys- tems (IIS)	Internationalisation of Higher Education (IHE)
Objectives	To strengthen national re- search system, contribute to innovation in firms, address the global problems related to environment, health and economy. Universalism-nationalism	To achieve global competitiveness, ac- cess new markets. Techno-globalism	To ensure the com- petitiveness of a country. Techno-nationalism	To enhance the quality of education, mobilise resources, advance in global rankings. Universalism- nationalism
Nature of activities	Cooperation and competition	Competition	Cooperation and competition	Cooperation and competition
Dominant actors	Integrated perspectives of universities, enterprises, gov- ernments and intermediary organizations	MNCs/enterprises	Government	Universities
Theoretical framework	Movement from 'mode 1' of knowledge production to 'mode 2'; social network the- ory; triple helix; dimensions of proximity; institutional the- ory; human capital theory	Resource based view, principal- agent theory, octo- pus model, interna- tional business theory, innovation theories	Social network theory, triple helix	Triple helix, human capital theory
Policy impli- cations	Inclusive at international lev- el: academics, enterprises, government	Inclusive at managerial level	Inclusive at govern- ment / international level	Inclusive at univer- sity as well as gov- ernment level

Source: Compiled by the authors

It follows that U-I IKT consists partly of the elements of IIS, IR&D and IHE as the central actors in the studies are either universities, enterprises or government that interact for KT purposes. There are studies that address the issue of KT more from the standpoint of a full word of universities (Howells and Nedeva, 2003; Hwang, 2010), those that analyze cooperation patterns of enterprises, both MNCs and SMEs, based on enterprise surveys (Arundel and Geuna, 2004; Broström, 2010; Fransman, 2008; Freel, 2003; de Zubielqui et al., 2015), and those that address the entire national innovation systems including the various actors that are part of it (Jin et al., 2011; Sorensen and Hu, 2014).

At the same time, U-I IKT is a domain in its own right. There are studies that do not employ a specific actor-related viewpoint and look at bilateral or trilateral relations between university-industry or university-industry-government. This is undertaken for example in the context of EU cooperation projects and networks (Caloghirou et al., 2001; Cooke et al., 2006; Araújo and Teixeira, 2013), co-publication analysis (Tijssen et al., 2009; Choi et al., 2015; Frenken et al., 2010; Kwon et al., 2012; Leydesdorff and Sun, 2009; Ponds, 2009; Ponds et al., 2007) and co-patenting analysis (Shin et al., 2012; Malik, 2013). These studies fall more under the stream of U-I IKT having features that are unique compared to other streams of literature.

## 5. Discussion and conclusions

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The paper aimed to construct a framework for understanding university-industry international knowledge transfer. This was achieved by synthesizing existing literature in order to answer the following research questions: (i) *Are there specific channels, motivations, activities and outcomes, and influencing factors characterizing university-industry international knowledge transfer*, and (ii) *How is the concept of university-industry international knowledge transfer related to the internationalisation of R&D, internationalisation of innovation systems and internationalisation of higher education*.

It was found that international KT shares many similarities with KT in general, but there are also additional complexities that collaborative activities across boundaries need to address. The channels suitable for U-I IKT depend on the content of university-industry cooperation, namely the nature of the knowledge to be transferred. Geographical distance has been found to be less disruptive for the transfer of explicit and basic research related knowledge, as it is difficult to transfer tacit knowledge over long distances and the more applied needs of enterprises can be addressed by local universities. Therefore, when a firm does not get the required quality of basic research at home, it collaborates with universities located in other countries particularly in the case of long-term R&D projects (Broström, 2010).

The basic motives for undertaking cross-border collaboration are that such co-publications (also with industry) tend to receive more citations than collaboration at national or regional level (Frenken et al., 2010). However, mainly large firms with export potential are involved in U-I IKT, while small firms involved in incremental innovations are more locally embedded (with the exception of R&D intensive small firms like academic spin-offs). In terms of geographical differences, peripheral universities, particularly in the European context are participating more in international university-industry joint ventures (Caloghirou et al., 2001); whereas, other universities in Europe and Asia-Oceania are collaborating more frequently with American countries than in their own regions (Choi et al., 2015).

The processes of U-I IKT in terms of how cooperation progresses through different stages have been addressed little by previous studies. Nevertheless, Sorensen and Hu (2014) have

documented the internationalisation process of an entire triple helix (university-industry-government), which advances from the establishment of each of the spheres abroad to actual helix-to-helix cooperation. The negative outcomes of U-I IKT are addressed in studies, as there are fears of domestically funded academic research leaking to foreign firms (Ponds, 2009) and more intensive international collaboration resulting in more applied research, shorter research time, delays in publications, and treating the needs of smaller domestic firms as secondary (Howells and Nedeava, 2003).

The studies dealing with the cross-border transfer of knowledge have shown that relationships, cultural awareness and common language are the key factors affecting the transfer of knowledge (Duan and Coakes, 2010). While higher absorptive capacity has been shown to contribute to increased cognitive proximity between the network partners, there are also findings that refute this (Araújo and Teixeira, 2013). Still, the probability of R&D projects being located in a host region is positively affected by the host region's academic strength even (Belderbos et al., 2014).

In addition to the characteristics of U-I IKT, the literature review also indicated that U-I IKT has common themes with studies in areas like IIS, IR&D and IHE, as all these streams of research address the issue of the transfer of knowledge, albeit from a different perspective. Although under each theme, there is a growing diversity of issues, like techno-national vs. techno-globalism and cooperation vs. competition, the topic of cross-border knowledge transfer echoes in all of them. However, there are also differences, as U-I IKT is different from IR&D, IIS and IHE in terms of objective and nature, actors, theoretical framework and policy implications. U-I IKT is unique from other areas of study in that it embodies a multi-actor view addressing the issue of KT from bilateral or trilateral university-industry or university-industry-government perspectives.

The paper contributes to the existing body of knowledge by proposing a framework of U-I IKT consisting of the characteristics of the KT process and its connections to other research streams in the area of the internationalisation of KT. Firstly, as with KT that takes place within national boundaries, IKT can also be understood as a process consisting of channels, motivations, activities and outcomes and influencing factors. U-I IKT is influenced by institutional differences between countries and by a lack of geographical proximity between the actors. A lack of geographical proximity in U-I IKT can be compensated through various ways like temporary geographical proximity and higher levels of absorptive capacity, but it requires an assessment of costs and benefits and a compromise in terms of the quality of knowledge and cost of cooperation. Secondly, U-I IKT is partly connected to other streams of research dealing with the issues of the internationalisation of KT. Although keywords related to IIS, IR&D and IHE were not used when searching for the articles, these concepts are present in U-I IKT studies. Therefore, the phenomenon of KT from universities to industries across national boundaries can be explored under four main themes – IKT, IIS, IR&D and IHE. Most of the studies on IR&D, IIS and IHE have analyzed KT from the perspective of enterprises, government and university respectively, whereas U-I IKT can be seen as a convergence of the perspective of government, university and industry overlapping with the boundaries of other streams of literature. As U-I IKT is concerned with cooperation between different types of actors from different institutional contexts over long distances, it increases the complexity of these networks. One way to manage this complexity is offered, for example, through EU research programmes and other inter-governmental organizations that provide a legal and financial framework for such cooperation.



In terms of analyzing U-I IKT studies, this type of meta-analysis needs to be repeated over the course of time, as at present only 26 studies were found that met the research criteria. A larger number of studies would allow for a more in-depth analysis of the elements of the U-I IKT process. It would be especially interesting to pursue studies that document the stages of activities undertaken in such a process. This would also make it possible to compare the channels, motivations, activities and outcomes, and influencing factors of IKT more systematically to the characteristics of KT within national boundaries. In addition, a further area of research consists of studying the institutional differences in international cooperation. This involves formal and informal institutions at country, organizational and individual level. Locating the most critical factors that should be present can prevent international collaborations from ending up in failure. Lastly, when university research systems are being internationalised, the apprehensions related to leaking domestically funded research and the marginalisation of local SMEs need to be addressed in future studies. The practices are different as some countries have policies in place that favour the commercialisation of intellectual property from universities to domestic firms, while others encourage commercialisation in general, including at the international level. It follows that there are different measures in place to deal with the negative consequences of the international transfer of knowledge, and these need further attention.

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