



International university-university technology transfer: Strategic management framework

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ABSTRACT

International technology transfer between universities is an emerging phenomenon and contributes to the socio-economic development of regions and countries. Technology transfer concerns transactions or long-term collaborations between acquirers and suppliers of technology. Based on strategic management theory, this study constructs a framework on the international technology transfer between universities. We theorize on the entry mode and pathway towards collaboration and apply the theoretical constructs to the cases of China and the Western economies, i.e., Europe and the US. By comparing the Chinese and Western perspective, we observe different entry modes and pathways of international university-university technology transfer. With regard to entry mode, the dominant Chinese perspective is to enter international technology transfer collaborations formally and with substantial resource commitments, while the dominant Western perspective suggests a more informal entry mode without the creation of a new entity. The Chinese pathway of international university-university collaborations on technology transfer is based on generating mutual confidence through formal arrangements and on replacing formal safeguards by informal arrangement as the collaboration matures, while the Western perspective suggests formalizing collaborations through a greater commitment of resources, which reduces managerial problems and allows collaborative learning.

1. Introduction

In addition to education and research, universities increasingly engage in technology transfer to contribute to the socio-economic development of their regions and countries (Guan et al., 2006; Perkmann et al., 2013). Technology transfer reflects transactions or long-term collaborations between acquirers and suppliers of technology (De Prato and Nepelski, 2014). In an academic setting, technology transfer occurs between firms, as acquirers, and universities, as suppliers of technologies. These collaborations are typically referred to as university-industry collaborations on technology transfer, and they play a vital role in fostering innovation (Etzkowitz, 2004; Hemais et al., 2005). By definition, innovation refers to the successful exploitation of new ideas. These ideas concern creating new or changing existing products, processes, organizational forms, and business models (Achi et al., 2016; Bessant and Tidd, 2015). We focus on the ensemble of parties who foster innovation and the interactions that appear as a consequence of these parties' common goal: the innovation system (Etzkowitz and Leydesdorff, 2000). Innovation systems are present on a local, regional, and national level but are increasingly internationally oriented (Heitor, 2015). Governmental and organizational initiatives in both developed

and emerging economies are devoted to the enhancement of the capabilities and efficiencies of these innovation systems (Fischer et al., 2017).

Within innovation systems, in addition to the traditional university-industry collaborations, *international university-university collaborations on technology transfer* (IUUTT) constitute an emerging form of technology transfer collaborations. In a flexible, global, and innovative business environment, going alone in technology development and its applications is too difficult to maintain (Inkpen, 1998a; Kim and Inkpen, 2005; Li, 2013). Therefore, to foster innovation, universities may access or acquire skills, technologies, and knowledge of their international partner universities, learn from their partners, create value in locations outside their home market, and enjoy diverse foreign economic policies (Hitt and Ireland, 2011; Kim and Inkpen, 2005).

Whereas a significant effort has been made to study university-industry collaborations on technology transfer, no such effort is made in an international university-university context. Given the emergence of IUUTT and to allow policy makers and practitioners to engage in IUUTT, we *build a strategic management framework on international university-university collaborations on technology transfer, and we propose entry points and pathways of these collaborations*. With regard to the

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framework, we first equate three IUUTT types to their strategic alliance equivalent and subsequently theorize the relationship between four key strategic management concepts and the different IUUTT types. Strategic alliances are fundamental instruments to transfer technologies across organizational boundaries and across countries (Inkpen, 1998a). We draw upon the knowledge-based view, as we consider these technologies, including the tacit and implicit knowledge related to these technologies, as the main resource of an organization to establish a competitive advantage (Grant and Baden-Fuller, 2004). We apply the accumulated knowledge on strategic alliances to a university-university setting to build our conceptual framework. With regard to the entry modes and pathways to IUUTT, we compare and contrast the Western, i.e., European and U.S., perspective with the Chinese perspective. Although a Western perspective on technology transfer is well documented, we lack insights into the Chinese perspective.

Given the specific cultural and organizational characteristics, there is a need to understand the dynamics behind collaborations with emerging markets (Culpan, 2009). Although China is the second largest economic power in the world, China still boasts significant economic growth, continues to open up its borders for international activities, and transforms itself from an imitation-based to an innovation-based country (Fisch et al., 2016). In developing countries, traditional technology transfer contributes to this growth by creating jobs and improving the quality of life (Larger, 2008). International university-university technology transfer creates similar advantages.

We find that different types of international university-university collaborations on technology transfer reflect the different strategic alliance equivalents. We find, based on existing literature and theoretical development, that different IUUTT entry points and pathways exist when comparing Western and Chinese perspectives. Drawing upon our findings, we (1) recommend flexibility to policy makers in allocating funding for innovative collaborative projects, (2) notify practitioners to recognize the apparent difference in Western and Chinese perspectives for their future engagement in IUUTT, and (3) stimulate researchers to validate the propositions made in this study.

2. Universities and technology transfer

2.1. International university-industry collaborations

University-industry collaborations on technology transfer are mainly defined by their processes and mechanisms of collaboration. The typical university-industry technology transfer process starts with a research result of the university scientist and ends with a license, on the intellectual property of that result, being transferred to a firm (Siegel

et al., 2003). In addition to patenting, start-up companies, i.e., university spin-offs, get attention as a mechanism of technology transfer (Wright et al., 2007). Literature initially focused on patenting and spin-off companies, as many governments emphasized these mechanisms because well-defined metrics on patenting and spin-off activities were easily available (D'Este and Patel, 2007; Siegel and Wright, 2015). More recently, scholars also focus on informal mechanisms of technology transfer, including collaborative research, contract research, and consulting (Perkmann et al., 2013).

University-industry collaborations on technology transfer are widely recognized as a means to develop innovative countries and take on an international character (Lundvall, 1992). In China, through international university-industry collaborations, foreign universities contribute to the innovative capabilities of Chinese industries (Jin et al., 2011). For example, Chinese companies learn new skills and competences by engaging in collaborative technological projects or they are able to explore new markets through their foreign partner university.

2.2. International university-university collaborations

Globalization and the interrelatedness of markets is considered a main driver to change the higher education sector and technology transfer is a means to get involved (Audretsch et al., 2015; Estorilio et al., 2017). On an international level, joint research projects, education, exchange programs and even competition have soared in the past years. The innovation engagements that universities pursue through their third mission of commercialization and technology transfer exceed the organizational and national level and increasingly gain a global character through increased numbers of international co-publications, cross-border patents, and human capital mobility (OECD, 2008). In their model, Jin et al. (2011) recognize the existence of international university-university collaboration on technology transfer, but they leave these collaborations out of the scope of their paper as they focus on international university-industry collaborations. In contrast, we focus on these international university-university collaborations on technology transfer.

2.3. University-university collaborations between China and Western economies

International joint research is a major route of international collaboration between universities, often resulting in joint publications. According to Web of Science (November 2016), China (7%) is the third largest global contributor to university publications, following the EU (35%) and the US (30%). Fig. 1 shows the rise in the share of

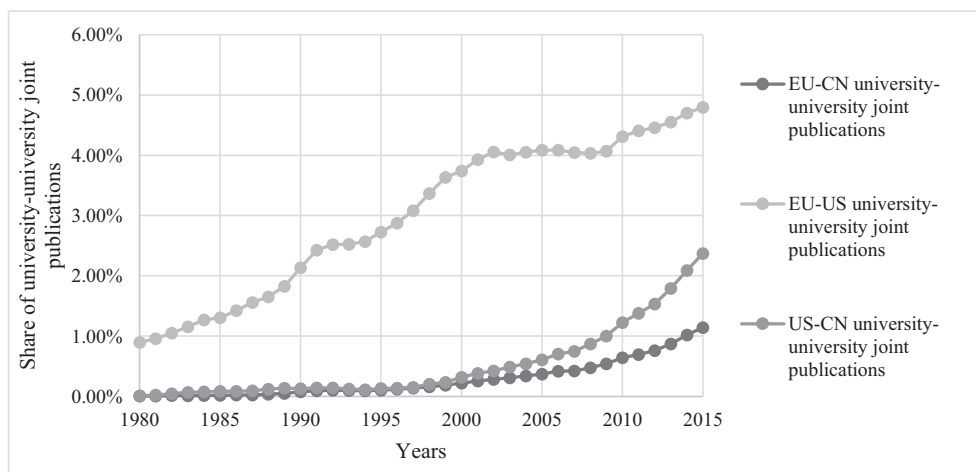


Fig. 1. The share of international university-university joint publications between 1980 and 2015. (Source: Web of Science, own set-up)

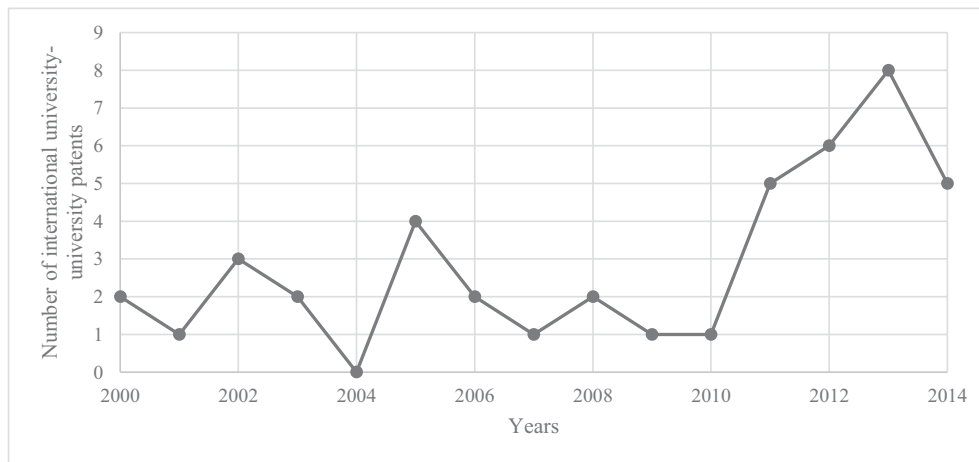


Fig. 2. International (WO) patent applications between EU-CN, CN-US, EU-US universities. (Source: Global Patent Index from the European Patent Office, own set-up)

international university-university publications between 1980 and 2015 relative to the total amount of joint publications between researchers in one of the three regions (Web of Science, 2016). Both the shares of EU-China and US-China joint publications show an exponential growth, which indicates that both Europe and US are embracing university-university collaborations with China.

International joint research may result in joint patenting activity between universities. Fig. 2 shows the emergence of international patent applications between European, Chinese, and US universities from 2000 to 2014 (retrieved from the Global Patent Index from the European Patent Office, 2017). We only consider patents listed as international patent applications, as these show the international intentions of the applicants. Since 2010, the amount of such patents has risen notably.

China is currently the world leader in number of patents filed. The Chinese patenting system meets international standards, and the amount of patent applications is increasing fast in light of governmental programs like China's National Medium and Long Term Science and Technology Development Planning (2006–2020) and the “Chinese Bayh-Dole Act”, which is implemented in 1993 (Fisch et al., 2016; Fong et al., 2015; Li, in press; World Intellectual Property Organization, 2016). Other programs, such as “The Belt and Road Initiative” and “The 13th Five Year Plan”, support China's transformation towards an innovation based country on a general level. Through these programs, universities are considered key actors in China's transformation. Improving the performance of Chinese university technology transfer is one of the most significant strategies. Due to this national commitment, we expect the number of international university-university co-patents with China to further increase over the coming years.

The human capital trends of Chinese universities also demonstrate China's commitment to invest in technology and innovation. Chinese universities increasingly collaborate on student or staff exchange programs and on joint PhDs. As an indication, the number of returned study abroad students and scholars increased by 2179% in the period 2002–2015 (Li, in press). Talent pooling and training stimulates knowledge generation and technology transfer. International PhD programs or joint graduate schools allow for cross-country research and access to technologies that otherwise would have remained unattainable. Such international exchanges are increasingly supported. For example, the China Scholarship Council (CSC) provides financial assistance to Chinese citizens wishing to study abroad and to foreign citizens wishing to study in China (China Scholarship Council, 2017).

3. Strategic management and international university-university technology transfer

We highlighted the prominent role of universities in innovation systems and positioned IUUTT as an emerging phenomenon, next to traditional international university-industry collaborations, within such innovation systems. As universities are increasingly triggered to operate internationally, we argued that IUUTT is a result of the globalization and interrelatedness of markets. We analyzed some of the key indicators, which highlight the emergence and growth of IUUTT between China and the West. In the following sections, we turn to theorizing on these collaborations from a strategic management perspective.

A strategy is defined as “an integrated and coordinated set of commitments and actions designed to exploit core competencies and gain a competitive advantage” (Hitt, Ireland, and Hoskisson, 2011, p. 27). Strategic management is a broad term defining the process that includes the top management's analysis of the environment in which an organization operates prior to formulating the strategy, as well as the plan for implementation and control of that strategy (Parnell, 2014). Since its inception in the 1950s, strategic management has drawn on industrial organization theory, contingency theory, and resource-based theory. The resource-based theory addresses an organization's unique combination of resources and has been proven to be a useful perspective for strategic management research (Barney, 2001). In the context of international university-university technology transfer, we turn to the knowledge-based view (Grant and Baden-Fuller, 2004), as we consider technologies, including the tacit and implicit knowledge related to these technologies, as the main resource of an organization to establish a competitive advantage.

3.1. International university-university technology transfer types as strategic alliances

In the strategic management literature, a strategic alliance is defined as an inter-organizational, in our case inter-university, cooperative arrangement that uses resources and/or governance structures from at least two legally independent organizations and involves exchanging, sharing, or co-developing products, technologies, or services (Inkpen, 1998a; Peng, 2009). In a strategic alliance, two or more parties commit to reach a joint purpose and pool their resources and activities (Teece, 1992; Todeva and Knoke, 2005). Typically, such arrangement is flexible and allows experimenting with new technological and organizational ideas (Mody, 1993). It is generally accepted that strategic alliances are hybrid arrangements, balancing between market transactions and acquisitions. In this paper, we distinguish between

equity alliances, with a focus on joint ventures, and non-equity alliances. Equity alliances involve the transfer or creation of equity ownership, whereas non-equity alliances do not involve any transfer of equity or the creation of a new organization and are rather managed by various contracts (Barney and Hesterly, 2012; Das and Teng, 2001; Inkpen, 1998a).

As we study *international* university-university collaboration on technology transfer, we need to consider the international dimension of strategic alliances. In an international context, differences in cultures, stakeholders, expectations, economic objectives, and time horizons are even more prevalent, which makes international strategic alliances especially difficult to manage (Hitt and Ireland, 2011; Lei et al., 1997). Differences between organizations in established and emerging economies add to the complexity, especially in the case of technology transfer (Lane et al., 2001). Culture, norms and values impact the economic and commercial activity and play a nontrivial role in guiding an organization's strategy (Johnson et al., 2013; Luo et al., 2010).

China has a unique country contingency and cultural environment (Shenkar and Von Glinow, 1994), which may influence the Chinese university's strategy towards (potential) international university-university technology transfer. This does not necessarily mean that cultural differences impede technology transfer with Chinese partners (Meier, 2011).

We define three types of IUUTT, i.e., international collaborations between universities in which: (1) universities act as supplier(s) and/or acquirer(s) of technologies (Type 1 IUUTT); (2) universities act as channels through which technology is exchanged (Type 2 IUUTT); or (3) universities jointly interact with industry (Type 3 IUUTT). We represent these three IUUTT Types in Fig. 3. Each of these IUUTT types has a strategic alliance equivalent and will be discussed in the following paragraphs.

3.1.1. Type 1 IUUTT as a non-equity strategic alliance

A Type 1 IUUTT is an international collaboration between universities in which universities act as supplier(s) and/or acquirer(s) of technologies. Through existing international strategies (education, talent exchange, joint PhDs, joint publication, and so on), partner universities leverage their collaboration to innovate. Each of them possesses information, skills, technologies, or knowledge (explicit, implicit, or tacit), generated individually or by collaborating with industry, that might be useful for the partner university.

We equate Type 1 IUUTT to a non-equity strategic alliance. Non-equity strategic alliances are contractual arrangements, on co-marketing, research and development, outsourcing, strategic suppliers, strategic distributors, collective research organizations, licensing, and franchising, to share some unique resources and capabilities and create a competitive advantage (Hitt and Ireland, 2011; Peng, 2009; Schilling, 2013). An R&D alliance, for example, is most suitable to create new technologies and foster innovation (Lin et al., 2012). No independent entity is established in non-equity strategic alliances.

Type 1 IUUTT is the least formal type of IUUTT. No ties link the organizations apart from the agreement set forth in the contract (Jones, 2013). Contracts can be oral or written, casual, shared, or even implicit.

Written contracts are generally drafted to specify procedures for sharing resources or information and for using the benefits that result from such agreements. Because of the informal character of non-equity strategic alliances, arrangements are often incomplete, and residual rights and authority are not (well) defined (Mody, 1993). In a university-university context, such contracts appear through bi-lateral agreements between universities or between two schools/departments of different universities.

3.1.2. Type 2 IUUTT as a network alliance

A Type 2 IUUTT is an international collaboration between universities in which universities act as channels through which technologies are exchanged. Universities form an international clustered network and use this network to leverage innovation and technology transfer between themselves and their industry connections. This type of university collaboration is, in contrast to a Type 1 IUUTT, of particular interest to (university) companies willing to access external and foreign technologies. When, for example, a company wants to explore a foreign market or acquire a foreign technology, it may access the academic network of a neighboring university to reach out to this foreign market or technology through their international collaboration with a foreign university. By helping their surrounding industries, Chinese and Western universities contribute to their mission of regional socio-economic development (Guerrero and Urbano, 2012; Lyu et al., 2017).

We equate a Type 2 IUUTT to a network alliance between universities, in particular a referral network alliance (Koza and Lewin, 1998). A network alliance is a cluster of different organizations whose actions are coordinated by contracts and arrangements rather than through formal hierarchy of authority (Jones, 2013). Generally, the goal is to achieve shared objectives (Hitt and Ireland, 2011). Members of this network work closely together to support and complement one another's activities and share resources and capabilities. Network alliances are key to discovering whether complementary capabilities make sense from a technological and market perspective and whether corporate cultures are compatible (Mody, 1993). They are a way for organizations to generate social capital in the form of prestige, reputation, status, and brand name recognition and to foster innovation (Hitt and Ireland, 2011; Todeva and Knoke, 2005). A Type 2 IUUTT is more formal than a Type 1 IUUTT. In a network alliance, more ties link member organizations, and there is greater formal coordination of activities (Jones, 2013). A commonly used global example of such alliance is Universitas 21 (Van Der Wende, 2001).

3.1.3. Type 3 IUUTT as an international joint venture

A Type 3 IUUTT is an international collaboration between universities in which universities jointly interact with industry. In this case, universities act as one entity towards industry and society to foster innovation and commercialization.

A Type 3 IUUTT reflects an international joint venture. Joint ventures are a strategic alliance and entail significant structure and commitment (Schilling, 2013). A joint venture involves a significant equity investment from each partner and often results in the establishment of a new separate entity. In a university setting, a separate entity may be

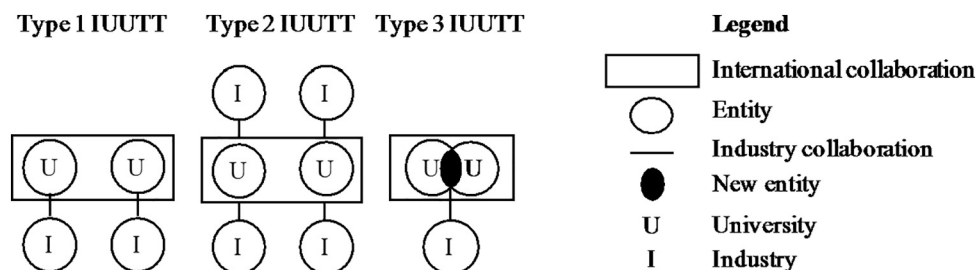


Fig. 3. Three types of international university-university technology transfer.

created with substantial commitment of resources but without any equity commitments. In a Type 3 IUUTT, traditional university-industry connections on technology transfer still hold, as two universities now act as one academic party towards industry. Partners share resources and capabilities and pool distinctive competencies to develop a competitive advantage (Hitt and Ireland, 2011; Jones, 2013). A Type 3 IUUTT is the most formal strategic alliance type. Participants of joint ventures are bound by a formal legal agreement that spells out their mutual rights and responsibilities (Jones, 2013). The newly created organization is free to develop the structure that best suits its needs. In a university context, universities increasingly set up campuses internationally and engage in university joint venture (Jin et al., 2011). Examples of the latter include Xi'an Jiatong Liverpool University, NYU Shanghai, and Wenzhou Kean University. In practice, Type 3 IUUTT may also be created on a school level through joint research institutes or laboratories between universities.

3.2. Key strategic management concepts in international university-university technology transfer

To construct a framework on international university-university technology transfer as strategic alliances, we apply key strategic management concepts to each of the IUUTT types. We consider the inter-related concepts of knowledge base, learning, absorptive capacity, and trust (Fig. 4). In the management literature, these four concepts appear numerous times as key dimensions of inter-organizational collaborations (see Alves et al., 2016).

We consider the expansion and access of the knowledge base and inter-organizational learning as the goals of IUUTT, and we consider absorptive capacity and trust as the necessary preconditions to achieve these goals and thus for IUUTT to occur at all. To achieve competitive advantage, an organization enriches its knowledge base, and inter-organizational learning is a way of doing so (Grant and Baden-Fuller, 2004; Ireland et al., 2002). To achieve learning, organizations need to build trust among themselves (Cullen et al., 2000; Ireland et al., 2002). In practice, this translates in organizations not being too protective of their technologies (Inkpen, 1998a). The amount of absorptive capacity describes the organization's ability to learn from a partner and is partly determined by its knowledge base (Steensma and Lyles, 2000). In the next paragraphs, we theorize on these concepts and their relationship with the different types of IUUTT.

3.2.1. The university's knowledge base

A knowledge base is an organization's stock of knowledge, including its technologies (March, 1991). Organizations reach out to acquire useful knowledge and to extend their knowledge bases (Inkpen, 1998a). This goal can be achieved by universities through engagement in IUUTT. Acquiring knowledge is a process where knowledge from university researchers is amplified and internalized as part of the university's knowledge base. Accessed knowledge may be complementary

to or compatible with the organization's knowledge base (Geringer, 1988). In the case of compatible knowledge, the possession of skills or resources of one university matches those of another university. In the case of complementary knowledge, a university possesses skills and resources that another university needs but does not have. Shenkar and Li (1999) found that, in an international context, accessing complementary knowledge is more opportune. An important note is made by Lane and Lubatkin (1998): to access this knowledge, one's knowledge base needs to be rather similar to the partner's knowledge base. This precondition holds in an international technology transfer context (Kalantaridis et al., 2017). This means that universities' knowledge bases should also be somewhat similar in order to operate internationally on innovation.

To extend their knowledge base, universities continuously improve their overall capabilities and resources, which results in exploration and exploitation activities (Szeto, 2000). Exploration concerns discovering new opportunities for wealth creation, innovation, basic research, inventions, risk taking, capacity building, new lines of business, or new investments (Koza and Lewin, 1998). In short, exploration activities increase the knowledge base (March, 1991). Typically, exploration activities do not involve any equity commitments (Koza and Lewin, 1998). Exploitation refers to an organization accessing another organization's knowledge base to exploit complementarities, but with the intent of maintaining a distinctive base of specialized knowledge (Grant and Baden-Fuller, 2004). This distinctive knowledge base may be held by individual universities or may be embedded in a jointly created entity. As a result, all three types of IUUTT allow exploitation activities, but the amount of exploitation activities differs (Fig. 5). Exploitation activities increase the productivity of capital and assets, refine existing capabilities and technologies, and aim at standardization, routinization, and cost reduction (Koza and Lewin, 1998).

Proposition 1a. If the primary goal of a university is to engage in exploration activities, it will more likely engage in a Type 1 or a Type 2 IUUTT.

Proposition 1b. The share of a university's exploitation activities is highest in a Type 3 IUUTT, balanced in a Type 2 IUUTT, and lowest in a Type 1 IUUTT, compared to the university's exploration activities.

Indeed, exploration mainly requires specialized knowledge to be accessible, whereas exploitation requires different types of knowledge (explicit, implicit, and tacit) to be accessible. The latter becomes easier once we move to Type 2 and Type 3 IUUTT.

3.2.2. Learning through IUUTT

Strategic alliances between organizations with different skills and knowledge bases create unique learning opportunities (Inkpen, 1998a,b; Mody, 1993). Learning is often seen as the ultimate goal of a strategic alliance and an enrichment of one's knowledge base (Grant and Baden-Fuller, 2004; Ireland et al., 2002). When not seen as primary goal of the alliance, learning is considered a derivative of other

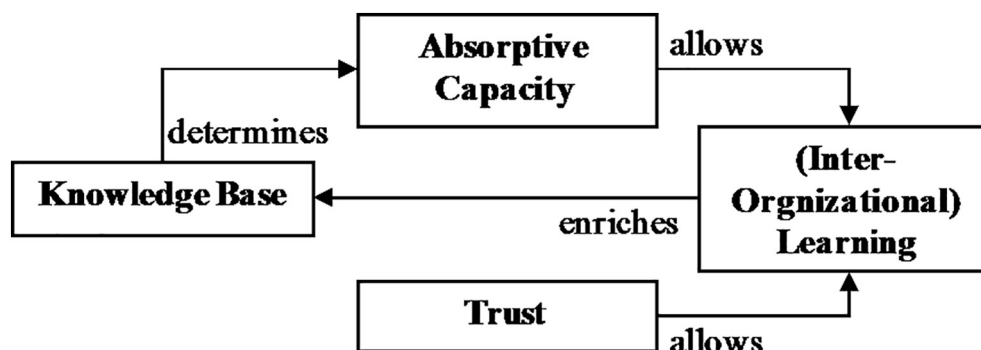


Fig. 4. Key strategic management concepts and their interrelatedness.

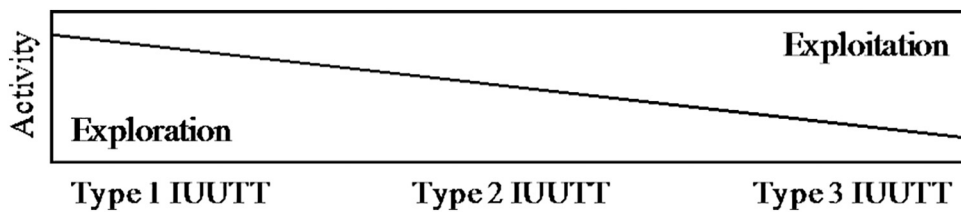


Fig. 5. Exploitation and exploration activities in different types of IUUTT.

objectives, such as new products and technologies or new market penetration. In an international context, strategic alliances allow learning how to create value by competing across national boundaries and in foreign markets (Barkema et al., 1997). Kim and Inkpen (2005) find that international strategic alliances have a strong positive effect on technology learning.

Learning through IUUTT or strategic alliances is dependent on a few conditions. We noted that, to successfully transfer technologies, the universities' knowledge bases should be rather similar. Indeed, such similarity enhances inter-organizational learning through absorptive capacity (Lane and Lubatkin, 1998). Tacit knowledge might be more difficult to acquire, and learning will be more tenable when alliance partners have worked together before. Past experiences in technology and knowledge collaborations have shown to be of importance in learning from partners (Kim and Inkpen, 2005).

A university will engage in a strategic alliance, in our case in IUUTT, to seek knowledge, i.e., technologies, it considers lacking but vital for the fulfillment of its strategic objectives (Shenkar and Li, 1999). The engagement is dependent on the absorptive capacity of the university and involves not only acquiring knowledge but also assimilating and applying knowledge to enhance long-run performance and competitive advantage (Todeva and Knoke, 2005). This knowledge includes patents, technical know-how, financial expertise, experienced managerial personnel, access to marketing or distribution channels, market access, and even connections with governmental agencies (Kogut, 1988). In China, for example, governmental support has a strong influence on innovation systems and plays an important role in the success or failure of collaborations (Chen et al., 2016; Su et al., 2018).

Learning in non-equity strategic alliances, and thus in Type 1 and Type 2 IUUTTs, requires the strategic alliance to be as flexible as possible (Mody, 1993). Even though knowledge transfer is often one-directional, and learning is often asymmetrical, there is a great opportunity to work in a knowledge-sharing environment that results in win-win situations for both partners (Inkpen, 1998a). A network alliance, in our case a Type 2 IUUTT, may be seen as an alliance used as a vehicle for accessing rather than for acquiring capabilities (Mowery et al., 1996). A joint venture, in our case a Type 3 IUUTT, allows for interactive learning between organizations (Lane and Lubatkin, 1998). This allows universities to add unique value to their own capabilities and to understand the more tacit *how* and *why* knowledge. Joint ventures allow the joint development of knowledge and rewards systems and aim at learning over time (Lei et al., 1997). They offer the greatest opportunity for learning core competencies and skills.

Proposition 2a. For a university, learning opportunities are especially possible in a Type 1 IUUTT, through asymmetrical learning, and a Type 3 IUUTT, through interactive learning.

Proposition 2b. Only a Type 3 IUUTT allows a university to learn new core competencies and skills.

3.2.3. Absorptive capacity of universities

Absorptive capacity facilitates knowledge transfer (Meier, 2011). Absorptive capacity refers to the general ability to value, assimilate, and commercialize new, external knowledge (Cohen and Levinthal, 1990). Absorptive capacity is a key determinant of whether external knowledge sources can be acquired and integrated (Jabar et al., 2011).

Applying the concept to IUUTT means that the ability of a university to source knowledge from another university is dependent on the similarity of their knowledge bases, organizational structures and compensation policies, and dominant logistics (Lane and Lubatkin, 1998).

Absorptive capacity is especially important in exploration activities (Inkpen, 1998a; Ireland et al., 2002), and thus in Type 1 and Type 2 IUUTTs, where specialized and complementary knowledge is transferred between universities. Absorptive capacity determines the rate and effectiveness of the internalization of knowledge and technologies (Koza and Lewin, 1998). The alignment of organizational processes and structures may be required to facilitate the interaction in a Type 2 IUUTT, but generating, using, and transferring new knowledge is not central to the intent of the alliance. In joint ventures, a Type 3 IUUTT in our case, absorption issues are relatively minor, as knowledge is directly embedded in the newly created organization.

Proposition 3. The need for absorptive capacity decreases in a Type 3 IUUTT.

Absorptive capacity influences the state and evolution of a certain type of IUUTT. Therefore, it is important for a university to investigate the factors determining their absorptive capacity, especially in technology-related areas (Mowery et al., 1996). In an international context, these factors include the effects of demand, appropriability, technological opportunity, commitment of university leaders, availability of flexible learning objectives, performance criteria, and cultural alignment between organizations, such as universities (Cohen and Levinthal, 1990; Inkpen, 1998a).

3.2.4. Trust in IUUTT

We define trust as the belief that a university's word of promise is reliable and that the university will fulfill the obligations in the alliance and make a contribution to the alliance (based on Inkpen, 1998a; Johnson et al., 1996). In addition, trust exists in the belief that a partner university will behave with goodwill towards the alliance. Trust is a social phenomenon and may mean different things at different times to different alliance universities. However, the importance of trust in strategic alliances is undisputed and is highlighted by Cullen et al. (2000). The authors state that (1) no formal agreements can account for every issue or contingency that may arise, (2) there is the potential for dysfunctional conflict and mistrust, (3) without trust, valuable information may be held back or taken advantage of, and (4) tacit knowledge would not be accessible without trust. Despite its importance, cultural, economic, and institutional differences across countries and between universities increase the difficulty of building trust in strategic alliances (Ireland et al., 2002), in our case in IUUTT.

We base the occurrence and growth of trust in IUUTT on three pillars proposed by Zucker (1986), through Parkhe (1998): institutional-based trust production, process-based trust production, and characteristic-based trust production. Trust production differs in the different IUUTT types: while institutional-based, process-based, and characteristics-based trust production are relevant to all IUUTT types, the dominance of one over the other differs from type to type. Institutional-based trust production builds on intermediate mechanisms to leverage trustworthiness between universities. Reciprocal agreements or non-recoverable investments, for example, prevent wrongdoing between partners before it occurs. Contractual safeguards or legal

stipulations in collaboration agreements may reduce the potential gains from cheating. Implicit guarantees – such as the international ranking of universities – may form a mechanism for institutional-based trust production. In China, for example, these international rankings are used to assess a potential partnership with another university. Institutional-based trust production is dominant in a Type 1 IUUTT. Process-based trust production assumes that trust can be developed from an IUUTT alliance itself. Certain projects, technologies, or collaborations may show a promising future, or universities may be reassured by a history of collaborations. As such, it is dominant in a Type 2 IUUTT, where previous collaborations may be embedded within the university network. Characteristic-based trust production, which is dominant in a Type 3 IUUTT, results from understanding or alignment of each other's societal and corporate cultures and encompasses purely formal mechanisms of trust.

Proposition 4a. In terms of trust production, institutional-based trust, process-based trust, and characteristics-based trust is the dominant form for a Type 1, Type 2, and Type 3 IUUTT, respectively.

Cheating and opportunistic behavior of partner universities may limit IUUTT. The ad hoc character of strategic alliances implies inefficiencies in trust and communication (Mody, 1993). Learning about partner universities' behavior and the larger environment results in new governing rules on the strategic alliance and can mitigate the risks of opportunism and cheating between universities. A decline of the opportunistic behavior of partners, as the knowledge content between partners grows, results in trust. Trust is thus a result of the nature and success of a strategic alliance.

Different strategic alliance types relate to different characteristics of trust (Das and Teng, 2001). We state that the level of trust needed is the highest in a Type 3 IUUTT and lowest in a Type 1 IUUTT. The flexible character of a non-equity strategic alliance, in our case applied to a Type 1 IUUTT, creates opportunities for cheating (Parkhe, 1998). One needs to guard against too much and too little trust at the same time (Mowery et al., 1996). Trust is especially needed in joint ventures to successfully transfer tacit knowledge from one partner to another (Meier, 2011). This is the case in a Type 3 IUUTT. Robson et al. (2002) showed that trust as a behavioral factor indeed has a significant effect on international joint ventures. In a network alliance, the social network of indirect ties is an effective referral mechanism for bringing firms together (Todeva and Knoke, 2005). This holds for a Type 2 IUUTT. Mutual confidence is enhanced as universities become aware of the possible negative reputational consequences of their own or others' opportunistic behavior.

Proposition 4b. As a result of an increased need for trust, cheating opportunities are highest in a Type 1 IUUTT, lower in a Type 2 IUUTT, and lowest in a Type 3 IUUTT.

3.3. Framework on international university-university technology transfer as strategic alliances

We first equated the three IUUTT types to their strategic alliance equivalent and subsequently theorized on the relationship between the four key strategic management concepts and the different IUUTT types. Respectively, this is visualized in the two left columns and four right columns of our conceptual framework (Fig. 6). At the very right of the framework, additional dimensions are displayed, drawn from the application of strategic management literature to the different IUUTT types.

4. Entry mode and pathway of international university-university technology transfer

The conceptual framework allows us to theorize on how practitioners initiate and develop IUUTT, i.e., it allows us to propose the entry

mode and pathway of IUUTT. To enter the global knowledge market, universities select the entry mode best suited to the situation at hand (based on Hitt and Ireland, 2011). The shift of a university into other IUUTT types forms the IUUTT pathway of that university. Similar to previous scholars (e.g., Li, in press), we compare the Western and the Chinese perspectives, as this allows us to better understand how different perspectives shape international innovation collaborations and socio-economic changes.

4.1. Western entry mode and pathway

The dominant entry point for Western universities is a Type 1 IUUTT (Fig. 7). A first reason for this choice concerns the shift from an existing informal to a formal strategic alliance. Once an informal collaboration is ongoing, partners may decide that more resources need to be invested and that the collaboration should move towards a formal structure (Mody, 1993). Second, a shift from a Type 1 IUUTT to a Type 2 or Type 3 IUUTT represents a shift from relatively easy to relatively complex transfers of technologies. The transfer of tacit knowledge, which has a more complex nature, for example, appears to be more effective in a joint venture setting than in purely contract-based alliances (Hitt and Ireland, 2011; Mowery et al., 1996; Shenkar and Li, 1999). Tacit knowledge cannot be codified; it is learned through joint experiences such as those taking place in international joint ventures. A joint venture can be seen as a mechanism reducing the problems of managing complex inter-organizational information exchange by sharing equity ownership (Jones, 2013). Third, joint ventures, to which we equated Type 3 IUUTT, typically put an emphasis on knowledge exploitation objectives, whereas non-equity-based alliances can be used for exploration activities (Grant and Baden-Fuller, 2004). Exploitation requires a diversity of many knowledge types, including tacit knowledge, which again is transferred typically in a Type 3 IUUTT. Lastly, absorptive capacity and organizational learning in strategic alliances support this entry mode and pathway proposition. The need for absorptive capacity reduces from a Type 1/2 IUUTT through a Type 3 IUUTT, as is the case for their strategic alliance equivalent (Kim and Inkpen, 2005). Strategic alliances closer to a hierarchical construct, such as a Type 3 IUUTT, outperform other strategic alliances in supporting collaborative learning (Mowery et al., 1996).

Proposition 5a. The dominant entry point for Western universities is a Type 1 IUUTT.

Sequentially, a Type 1 IUUTT entry mode can be followed by a Type 2 or Type 3 IUUTT. A Type 3 IUUTT follows a Type 2 IUUTT as collaborations formalize even more. Jumping from a Type 1 IUUTT to a Type 3 IUUTT is possible but less likely to occur, as a Type 2 IUUTT is a way to build up a reputation and to gain trust with particular partners before engaging in a joint venture. A Type 2 IUUTT is an intermediate mode in the IUUTT pathway for two reasons. First, a Type 1 IUUTT is the ideal mode for establishing pilot projects with new universities on international technology transfer. As a result, a Type 2 IUUTT structure results from extending these initial projects; universities gain experience with several partners and can use their network to leverage new international technology transfer projects. Second, pilot projects from a Type 1 IUUTT increase the university's reputation, which triggers the ability to use its proprietary international technology transfer network more extensively.

Proposition 5b. The shift from a Type 1 IUUTT to successively a Type 2 and Type 3 IUUTT forms the dominant pathway for Western universities.

4.2. Chinese entry mode and pathway of IUUTT

Chinese culture is characterized by considerable acceptance of power differences, which leads to Chinese partners often preferring a

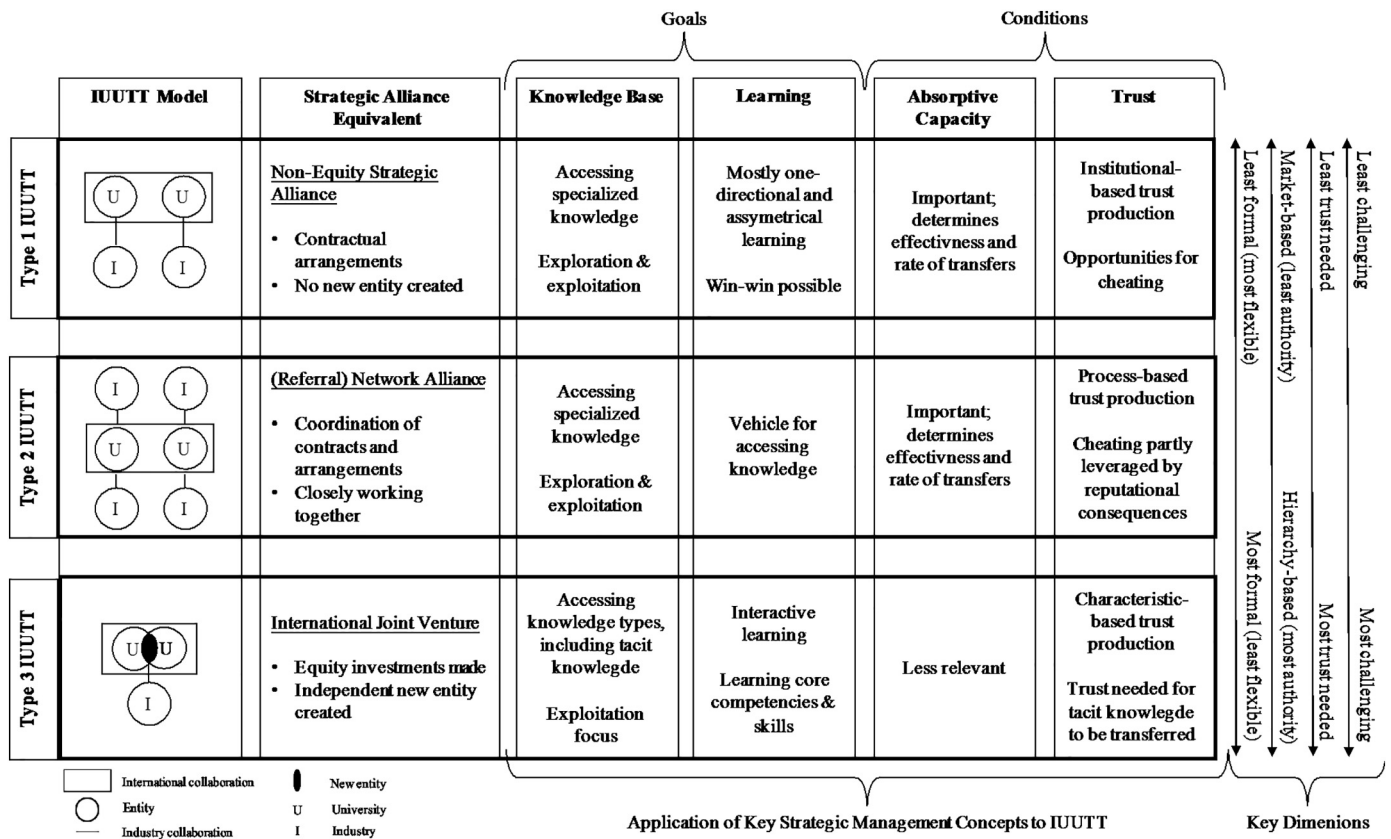


Fig. 6. Framework on international university-university technology transfer as strategic alliances. (Source: own elaboration)

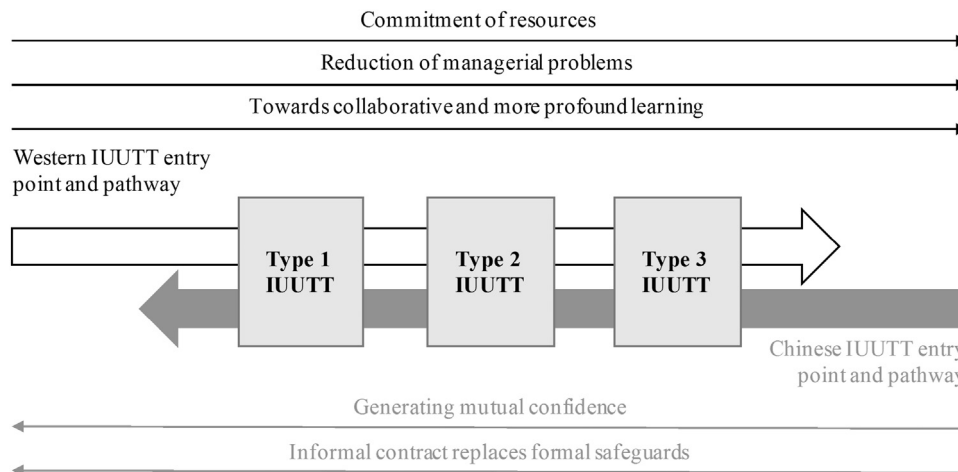


Fig. 7. IUUTT entry mode and pathway. (Source: own set-up)

foreign partner to retain hierarchical control over alliances (Reus and Rottig, 2009). As a result, collaborations may be most comfortable for Chinese organizations when a hierarchy is in place with clear positions and rules, as it provides a sense of security that may prevent partner conflict (Hofstede and Bond, 1988). Generally, this setting tends towards formal arrangements. Chinese values and norms also emphasize the avoidance of losing face (Yau-fai Ho, 1976). This norm expresses itself through the avoidance of direct confrontation, open criticism, and controversial topics of discussion. Avoiding losing face is also reciprocal in alliances; Chinese partners aim at saving not only their own but also others' face by avoiding displaying behavior that might embarrass

someone or lowers one's status.

Culture is not the only factor that needs consideration in a Chinese context. We also need to consider the business and organizational environmental factors (Todeva and Knoke, 2005). Strategic alliances, in a business environment, are often constrained or stimulated by governmental institutions. As is the case with China, strategic alliances often need formal approval by provincial or even the national government. Collaborative R&D projects and joint research laboratories are typically government funded.

Given the specific cultural and organizational characteristics, there is a need to investigate which kind of strategic alliances are successful

in emerging markets such as China (Culpan, 2009). As such, the Chinese context, which boasts high levels of conflict avoidance and hierarchical control, would suggest an international joint venture, i.e., a Type 3 IUUTT, to be the entry mode (Fig. 7).

Proposition 6a. The dominant entry point for Chinese universities is a Type 3 IUUTT.

Hierarchical control in China lowers partner conflict in joint ventures, while for international joint ventures in other countries, it amplifies partner conflict (Reus and Rottig, 2009). This may be the reason why most studies with a Chinese context focus on international joint ventures as a strategic alliance (Luo, 2000) and why the National People's Congress of China adopted laws to stimulate the creation of international joint ventures (Reus and Rottig, 2009). International joint ventures are subject to tension over incompatible objectives, capabilities, or constraints, but the strategic interdependence is a salient feature of successful alliances in dynamic markets (Sanchez, 1994). Another indication of the relevance of hierarchy in IUUTT is the important role governments play in China concerning international collaboration. Since China has a different cultural context, learning and absorbing tacit knowledge might be harder to manage (Lane and Lubatkin, 1998; Lei et al., 1997). This obstruction might be alleviated in a Type 3 IUUTT, where tacit knowledge is generally more accessible. Third, trust in China is very important. Generally, cultural, economic, and institutional differences across countries increase the difficulty of building trust (Ireland et al., 2002) and may lead to misunderstandings (Reus and Rottig, 2009). In China, the importance of long-term relationships and social control mechanisms, tending towards characteristic-based trust production, is extremely relevant and used to gain trustworthiness (e.g., loosing face). This reason also tends towards a Type 3 IUUTT, where trust is key and formalized, compared to a Type 1 IUUTT, where opportunities for cheating are more present. Lastly, formal contracts are only the starting point in China (Cullen et al., 2000; Reus and Rottig, 2009). As little ground for trust exists in potential university partners, equity-based contracts are mechanisms for legal protection against potential opportunism or cheating. Once mutual confidence is created, informal contracts replace the formal safeguards over time in China (Ring and Van de Ven, 1994; Todeva and Knoke, 2005).

This last point already suggests the direction of the pathway of IUUTT from a Chinese perspective. International collaborations with Chinese universities would lose their formal character over the collaboration's lifetime and, through Type 2 IUUTT, turn into Type 1 IUUTT collaborations, the most informal type of collaborations. The step towards Type 2 IUUTT builds on China's business climate of network capitalism fostering business collaborations (Boisot and Child, 1996).

Proposition 6b. The shift from a Type 3 IUUTT to successively a Type 2 and a Type 1 IUUTT forms the dominant pathway for Chinese universities.

5. Implications

5.1. Practical implications

Our study draws some implications for practitioners of IUUTT, i.e., universities. Strategic alliances are embedded in a larger strategic portfolio (Koza and Lewin, 1998). So are international university-university collaborations on technology transfer. This implies that universities manage a set of (IUUTT) collaborations in parallel with different universities but also with one particular university. Collectively, strategic alliances form a portfolio of information and technology sources (Mody, 1993). IUUTT should be perceived similarly; as a way, in addition to traditional university-industry technology transfer, to increase the chances of acquiring the right technologies through these collaborations.

Our conceptual IUUTT framework and propositions provide a basis for universities to understand and explore IUUTT in practice. Our findings regarding the contrasting entry mode and pathway of Western and Chinese universities in IUUTT imply that different universities, from both developed and emerging economies, may conduct and perceive an international technology transfer strategy in different ways. Academics need to be aware of possible differences with partner universities in collaborations, such as their cultural motives and organizational structures, to leverage international innovation collaborations. The international dimension is crucial, as differences in cultures, stakeholders, expectations, economic objectives and time horizons impede the management of international collaborations (Hitt and Ireland, 2011; Lei et al., 1997). Particularly, the challenges of technology transfer grow substantially when technology transfer occurs between organizations in both developed and emerging economies (Lane et al., 2001). For example, although counter-intuitive from a Western point of view, formal approaches, equity commitments, and the creation of new entities are entry point characteristics from a Chinese point of view. As a result, international collaboration with China often includes a formal signature (e.g., memorandum of understanding) and governmental involvement. In contrast, international collaboration with China allows for the quick and easy formation of joint research labs. Another example is that practitioners often assume that a product or technology can be easily reproduced or operated without major problems in another environment. This is not the case in practice (Wekerle et al., 2017). Other barriers for practitioners appear on a human, social, or regulatory level (Estorilio et al., 2017).

Concerning the regulatory level, with regard to stimulating international technology transfer activities, we recommend policy makers to allocate funding, targeted towards technological innovations, in a more flexible way to different countries. Currently, for example, European funding is directed towards a Type 1 IUUTT (equivalent of non-equity strategic alliances), which impedes international technology transfer opportunities with China, which targets a Type 3 IUUTT as a starting point for collaboration. Co-funding from governmental agencies in this context might not only leverage the difficulties of international collaboration in an IUUTT context but also be a particularly helpful strategy for a state to use to induce demand for new technologies (Bobrowski and Bretshneider, 1994).

5.2. Implications for further research

IUUTT as an emerging way of technology transfer for universities is in need of future research. The proposed IUUTT types and the Western and Chinese entry mode and pathway need further validation. Overall, the emerging research topic on international technology transfer (with China) may benefit from case studies on IUUTT, in-depth interviews with academics, and surveys. Longitudinal studies are needed to investigate the proposed pathways of international technology transfer with China and to determine critical success and failure factors for the different types of technology transfer.

The literature on cross-national technology transfer has the tendency to focus on one-way technology transfer, from developed countries to developing countries (Estorilio et al., 2017). Future studies should take into account the bidirectional character of a partnership and not merely investigate one-directional flows by investigating both sides of a partnership simultaneously. For example, international technology transfer constitutes a learning process for both countries involved and requires joint commitment to ensure a successful transfer.

A university is known to have a three-level hierarchy: university management, university faculty, and individual researchers. In our study, we have made abstraction of these levels, but the issue of centralizing or decentralizing technology transfer within universities is a prominent one and has been studied on several occasions (e.g., Borrás and Edquist, 2013). Our IUUTT framework and propositions need further investigation from at the three different managerial university

levels.

6. Conclusion

Universities, in both emerging and developing countries, are key actors within innovation systems and engage in technology transfer in different ways to contribute to the socio-economic development of their regions and countries. University-industry collaborations on technology transfer, whether international or not, constitute an established way for universities to foster innovation. Joint publication and patent application data support the emergence of another way for universities to conduct technology transfer, i.e., international university-university collaborations on technology transfer. We use the knowledge-based view to construct a framework on international technology transfer between universities, along with seven propositions, and to propose a dominant entry mode and pathway on IUUTT from the Chinese and Western perspectives.

We identified three main types of international university-university technology transfer, Type 1, Type 2, and Type 3 IUUTT, respectively equating a non-equity strategic alliance, a (referral) network alliance and an international joint venture. Four key strategic management concepts, knowledge base, learning, absorptive capacity, and trust, were applied to these different IUUTT types, resulting in seven propositions. We find contrasting entry points and pathways for the Chinese and Western perspectives. The Western perspective suggests a Type 1 IUUTT (the equivalent of a non-equity strategic alliance) to be the predominant entry point for IUUTT. However, in a Chinese context, this entry point does not hold. Unique cultural and organizational aspects make the argument for a different perspective on IUUTT: a Type 3 IUUTT (the equivalent of an international joint venture) is proposed to be the dominant entry mode. Similarly, the subsequent pathways for IUUTT differ: whereas the Western perspective encourages the movement towards more formal structures over time through commitment of resources, reduction of managerial problems, and collaborative learning, the Chinese perspective embraces the reduction of formal structures through increased confidence and trust.

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