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What do we need from intermediaries for technology transfer to China? A European firm perspective

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Cross-national technology transfer has been one of the most important vehicles by which firms in developed countries exploit the value of their technological innovations, and firms in developing countries gain access to technological and organizational knowledge from developed economies. To facilitate technology transfer between technology providers and recipients and to compensate for the weakness in the system of innovation, the role of technology intermediaries as bridging organizations has been widely recognized and discussed. This study deepens our understanding of the role of intermediaries by, first, reconciling the role and functions of technology intermediaries in the literature to a competence level based on a resource-based view in a specific context of technology transfer between Europe and China; and second, investigating whether certain competences of intermediaries are of more importance than others for European technology holders in relation to three different types of intermediaries – governmental agencies, private commercial agencies and web-based marketplaces.

Introduction

Cross-national technology transfer has been one of the most important vehicles by which firms in developed countries exploit the value of their technological innovations, and firms in developing countries gain access to technological and organizational knowledge from developed economies (Marcotte and Niost, 2000). Given the prosperous economic partnership between Europe and China, it is not surprising that technology transfer and patent transactions from Europe to China have drawn the attention of both researchers and practitioners (e.g. Chen and Sun, 2000; Bennett *et al*., 2001; Bruun and Bennett, 2002). Transferring technologies to Chinese firms has proved to be a challenging task for European firms (Liu *et al.,* 2008). Despite the strategic importance and managerial challenge, there have been few studies on the role of technology intermediaries in facilitating technology transfer from Europe to China.

The literature on systems of innovation, inter-firm technology transfer, innovation management and networks has recognized and discussed the role of intermediaries as bridging organizations to compensate for weakness in the system of innovation (Carlsson, 1994; Bozeman, 2000; Sapsed *et al*., 2007). Many

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functions of technology intermediaries, such as information scanning and exchange, technology foresight, diagnostics and evaluation, have been identified and discussed (Howells, 2006; Lichtenthaler and Ernst, 2008b). However, there is a need for theory and empirical evidence upon which a holistic framework can be developed to categorize the roles of technology intermediaries. In the absence of such a theoretical foundation, the literature simply enlists the roles of technology intermediaries for a general purpose without considering the competences that technology providers and recipients need – and often lack. In addition, the roles and functions of technology intermediaries are usually discussed within a single national innovation system (e.g. van der Meulen and Rip, 1998; Howells, 2006; Sapsed *et al*., 2007; Kodama, 2008). Thus, we are given little insight into how the role of technology intermediaries differs in cross-national technology transfer as opposed to domestic technology transfer.

This study has two purposes. First, it takes a resource-based view of technology transfer between Europe and China to reconcile the roles and functions of technology intermediaries in the literature by shifting the theoretical construct from a functional level to a competence level. Second, it investigates whether certain competences of intermediaries are of more importance than others for European technology holders, and looks specifically at three different types of intermediaries: governmental agencies, private commercial agencies and web-based marketplaces.

This study contributes to the literature in several ways. First, it focuses on the competences that technology-providing firms lack, and which determine the roles of technology intermediaries. It examines the functions of technology intermediaries discussed in the literature and provides a coherent configuration of their roles. It is the first study of different types of intermediaries in the specific context of technology transfer between Europe and China. The study also highlights the important compensating roles of technology intermediaries for the weakness existing not only in sectoral systems of innovation, but also across national systems of innovation. Finally, the findings of this study make suggestions for the design of innovation policy.

Theoretical background

Technology intermediaries: roles and types

Technology transfer is one of the most important means by which innovative knowledge can be recombined and diffused among organizations (Bozeman, 2000). Effective technology transfer requires not only technology providers and recipients, but also bridging organizations to fill the gaps between technology transfer agents and to compensate for weaknesses in a sectoral system of innovation (van der Meulen and Rip, 1998; Howells, 2006). Weaknesses exist because certain sectors may be favored by particular national endowments and institutional arrangements. They also exist because dominant technology trajectories may be favored by industries to the neglect of uncertain and risky technology, likely to be disruptive and unlikely to secure resources for development (Sapsed *et al*., 2007).

The literature in technology transfer, innovation management and systems of innovation has identified various roles for technology intermediaries (Howells, 2006; Lichtenthaler and Ernst, 2008b). The roles of intermediaries for technology transfer can be summarized as: (1) scanning and exchanging information; (2)

building linkages with external knowledge providers; (3) providing specific knowledge of technology and industries; (4) articulating, diagnosing and evaluating technologies to be transferred; (5) establishing relational binding for technology transfer agents to facilitate transactions; and (6) providing guidance and implementing innovation policy (van der Meulen and Rip, 1998; Howells, 2006).

The roles of intermediaries may also differ in relation to their types. The heterogeneous nature of intermediaries allows for various methods of classification in the literature (Morgan and Crawford, 1996). Here, a simple classification is adopted, integrating various relationship patterns suggested by prior studies. Each type of intermediary has a different functional emphasis. First, governmental/public intermediaries are usually public institutions that function between the policy level and the operational level to provide general guidelines and monitor the implementation of national innovation policies (van der Meulen and Rip, 1998; Yusuf, 2008). Second, private commercial intermediaries, including technology consultancies, patent and licensing brokers and specialized venture capitalists, provide their customers with various services to facilitate specific technology transfer processes and transactions (Lichtenthaler and Ernst, 2008b; Yusuf, 2008). The third type of intermediary is the web-based technology marketplace, whose primary role is to facilitate contact between technology providers and seekers on a virtual platform (Nambisan and Sawhney, 2007; Lichtenthaler and Ernst, 2008a). Both governmental and private intermediaries interact largely with technology providers and seeker firms in a 'many-to-one-to-one' or 'one-to-one-to-many' relationship, while the web-based technology intermediaries have a 'many-to-one-to-many' relationship (Howells, 2006). Although the role of intermediaries has been discussed in the literature from various perspectives, we still have little knowledge of how these roles differ in relation to different types of intermediary. This is important because firms need to find the right intermediaries to compensate for their missing competences.

Compensating for the lacking competences

Because there is no common theory, discussion of the roles of intermediaries in technology transfer is scattered across different fields in the literature, and little consideration is given to the needs of technology providers and seekers (Howells, 2006; Sapsed *et al.*, 2007). This paper takes a resource-based view to identify several competence-based roles of intermediaries within a sectoral system of innovation from a technology provider's perspective.

Resource-based theory argues that a firm's competitive advantage lies in its assets, competences and capabilities (Barney, 1991). While assets are physical resources, competences are bundles of skills, knowledge, know-how, systems and technologies applied in the utilization and mobilization of a firm's assets (Amit and Schoemaker, 1993; Hamel and Prahalad, 1994). Without these competences, a firm would not have the capabilities to achieve business objectives and eventually gain competitive advantages (McGrath *et al*., 1995; Teece *et al*., 1997). For a technology-providing firm, identifying the application of technologies, finding the right technology recipients and developing technologies alongside these technology recipients can sometimes prove to be a challenge. It is even more difficult if technology is to be transferred across sectors and nations. A firm's internal assets and competences, in this case, are not always sufficient to cope. Therefore, technology providers need external sources of competences in order to realize the value of their

technologies. Technology intermediaries extend a firm's competences by identifying technology transfer opportunities and developing capabilities to exploit the value of their technologies (Lichtenthaler and Ernst, 2008b). From a systems perspective, intermediaries form additional interfaces which compensate for the weakness of the entire system by connecting technology-providing firms with technology-seeking firms (Sapsed *et al*., 2007).

A thorough literature review on the role of intermediaries reveals three main competences that technology providers lack and intermediaries can supply (van der Meulen and Rip, 1998; Howells, 2006; Sapsed *et al*., 2007). First, the bridging and brokering functions of intermediaries expand the networks of technology providers and connect them with potential partners who could not be reached within the technology providers' own networks (Burt, 2005). Through the networks of intermediaries, a technology-providing firm can gain access to a wider range of information (Hargadon and Sutton, 1997). Second, there are transaction costs for each potential or realized technology transfer. A technology-providing firm itself might not be able to afford these transaction costs without the help of intermediaries. Intermediaries help to reduce transaction costs at various stages of the transactions by analyzing, diagnosing and evaluating the technology and market (Bessant and Rush, 1995; Hargadon and Sutton, 1997), facilitating contract negotiation and settling intellectual property rights (Nambisan and Sawhney, 2007; Lichtenthaler and Ernst, 2008a), and even sometimes utilizing personal relationships to smooth a deal (Howells, 2006; Lichtenthaler & Ernst, 2008a). The third competence of technology providers is specific knowledge of certain technologies and industries. Even though a firm is specialized in certain technologies, it may still lack a comprehensive view of all the alternative applications of its technologies. The firm may also lack complementary knowledge to turn its technologies into marketable products. It is even more difficult for a technology holder to explore application areas in unfamiliar industries. Therefore, intermediaries with specific technical and market knowledge in certain industries can contribute to the competence of technology-holding firms and compensate for the weakness of the innovation system (Howells, 2006).

The Europe–China context

Technology providers may lack specific knowledge of technology recipients. This weakness in the innovation system exists not only across sectors and technological trajectories, but also across nations (Carlsson, 1994). Although the roles of intermediaries have been discussed in the literature within specific national innovation systems (van der Meulen and Rip, 1998; Howells, 2006; Kodama, 2008), they are under-explored in cross-national settings.

The specific cross-national setting chosen for this study is inter-firm technology transfer between Europe and China. China has become the fourth largest export partner and the second largest trade partner for the EU, while the EU has long been the largest trade partner for China. Not surprisingly, the issue of technology transfer from Europe to China has drawn great attention from both researchers and practitioners (e.g. Chen and Sun, 2000; Bennett *et al*., 2001; Bruun and Bennett, 2002). The EU–China high level economic and trade dialogue mechanism was started to coordinate policies and practices in high technology trade from 2008. An amendment of the patent law in China that aims to strengthen patent protection was passed in December 2008 and took effect in October 2009. The new patent law for

the first time makes clear the definition of invention patents, utility models and design patents. It has also eased the procedure for patent applications and transactions, and increased punishments for patent infringement and counterfeiting.

The institutional environment, including the legal framework and culture, can effect technology transfer from developed countries to China (Marcotte and Noist, 2000; Luo, 2005; Liu *et al*., 2008). European technology holders to various extents need intermediaries with sound knowledge of the Chinese institutional environment to help manage country-specific influences when transferring technology to China. In sum, European technology-holding firms may lack the competences to manage technology transfer to Chinese firms. Intermediaries compensate for weaknesses in four particular competences:

(1) Networking;
(2) transaction costs;
(3) industry-specific knowledge; and
(4) country-specific knowledge (culture and legal systems).

Given the specific circumstances of transactions between Europe and China, technology-holding firms may differ in the compensating competences they need, and types of intermediaries they prefer. Thus, this study is interested in answering the following research question: to transfer technologies to China, which compensating competences of intermediaries do European technology holders require?

Research design and methods

The population of our study is defined as European firms active in technological innovation and industrial research and involved in the management of technology transfer. This definition of the population includes firms that have not had experience in licensing/selling patents to China. A sample frame containing two major sources of information was chosen. First, we searched for contact information for firms that are members of the European Industrial Research Management Association (EIRMA). EIRMA is an independent, non-profit organization that aims to help member firms improve R&D performance and enhance innovation. EIRMA has over 150 members based in more than 20 countries and operates in a wide range of sectors. Second, we contacted the Licensing Executives Society Europe (LES Europe), which responded positively. LES Europe is a non-profit organization that aims to encourage high standards, expertise and ethics among persons engaged in licensing and transferring technology. LES Europe has members in more than 20 European countries. The purpose of using these two sources is to identify the overlapping firms that are active both in industrial research and industrial property licensing in Europe.

To increase the size of our sample, we employed a snowball-effect strategy, asking respondents in a questionnaire to list other potential respondents. European companies that were not members of EIRMA and LES Europe were asked whether they were active in technological innovation and industrial research, and involved in technology transfer. To check for possible bias from including these non-EIRMA and LES firms, we compared some major attributes of technological innovation and intellectual property licensing between EIRMA and LES firms and non-EIRMA and LES firms. The mean difference between these two groups of firms with respect to the

Table 1. Summary of the number of sample firms by size and industry

Industry/firm size	<50	51–250	251–1000	>1000
Pharmaceuticals	3	1	0	1
Biotechnology	8	2	1	0
Chemical	1	3	2	2
Medical equipment	2	1	0	1
Agriculture	1	0	0	1
Construction engineering	4	0	2	0
Other	5	0	1	3
Total	24 (53%)	7 (15%)	6 (13%)	8 (18%)

number of non-commercialized patents, activeness in patent transactions and firm size was tested using an unpaired *t*-test. The results demonstrated that all *t* statistics were insignificant. Finally, 278 EU firms were identified as potential participants.

We used an online questionnaire to conduct our research. [Shannon and Bradshaw (2002) found that online surveys have a faster response time than paper surveys.] We used mostly fixed-response alternative questions in our questionnaire (see the Appendix). A request to complete a questionnaire was sent to the participants by email and a link to the questionnaire was provided. The respondent from each firm was either the head of a firm's corporate intellectual property department or a manager responsible for the firm's intellectual property transactions. To increase the response rate, we promised the respondent a present for completing the questionnaire. We also promised to treat the information on patent licensing as confidential and to publish only aggregate licensing trends (data on commercialization of patents are usually highly confidential). A total of 64 firms participated in the study, a response rate of 23%. Among these 64 firms, data were sufficiently complete from 45 firms. Some are large multinationals and others are small specialized firms. These firms are based in 12 EU countries, namely the UK, France, Germany, the Netherlands, Belgium, Austria, Switzerland, Finland, Italy, Norway, Sweden and Hungary. The firms in the sample also cover many different industries. A summary of firms by size category and industry is shown in Table 1.

Multiple items were used to measure lack of competences of European technology-holding companies. The Cronbach's alpha for networking, transaction costs and industry-specific knowledge are 0.792, 0.778 and 0.813, respectively, which indicates a satisfactory level of reliability. For China-specific knowledge, two single items were used separately. Specific knowledge of Chinese culture captures cognitive and normative dimensions, and the Chinese legal system captures the regulatory dimension of the institutional environment in China (Liu *et al*., 2008). A five-point Likert scale was used for each item. As there was only one informant per firm, a common method bias may exist. We followed procedures suggested by Doty and Glick (1998) and found no common method bias.

Results

Descriptive statistics are provided in Table 2. Among the three types of intermediaries, private commercial agencies are the most favored (mean value 3.139) and the web-based marketplaces are the least favored (mean value 1.829) for European firms considering technology transfer to China. Among the lacking competences of

Table 2. Descriptive statistics

	Minimum	Maximum	Mean	s.d.
Governmental agency	1.0	5.0	2.833	1.2340
Private commercial agency	1.0	5.0	3.139	1.1511
Web-based marketplace	1.0	5.0	1.829	0.8915
Licensee network	1.0	5.0	3.972	0.9883
Transaction cost reduction	1.0	5.0	3.880	0.8532
Industry-specific knowledge	1.0	5.0	4.000	0.8790
Chinese culture	1.0	5.0	4.056	1.0648
Chinese legal	1.0	5.0	4.278	0.9911

N=45.

European firms, specific knowledge of the Chinese legal system has the highest score (mean value 4.278) and transaction cost reduction was of least concern (mean value 3.880). The mean value of variables only presents a general picture of European firms' preferences.

To analyze the relationships between the types and competence-based roles of technology intermediaries, given the limited sample size, a canonical correlation analysis was used. This is because it is an appropriate procedure to examine the correlation between two sets of variables if each set can be given some theoretical meaning. Each canonical function is actually based on the correlation between two canonical variates, one variate for one set of variables and one for the other set of variables (Hair *et al*., 1998). As shown in Table 3, the test of canonical dimensions indicates that one canonical variate, which could be understood as a latent variable,

Table 3. Result of canonical correlation analysis

Dimension reduction analysis					
Dimension	Canonical corr.	F	d*f*1	d*f*2	P
1	0.64196	2.59489	15	102.54	0.002
2	0.48494	1.76062	8	76.00	0.098
3	0.26346	0.96967	3	39.00	0.417
Canonical correlation loadings					
Intermediary type					
Governmental agency	0.5865				
Private commercial agency	0.9390				
Web-based marketplace	0.4811				
Compensating roles					
Licensee network	0.9413				
Transaction cost reduction	0.6371				
Industry-specific knowledge	0.5417				
Chinese culture	0.6543				
Chinese legal	0.6732				

N=45.

is significant. This can be interpreted as these two sets of variables being related in one unique, meaningful way. The larger the canonical correlation loading, the more important the observed variable is in deriving the canonical variate. Our interpretation of significant loadings is based on a rule of thumb that 0.60 is a good indication of strong correlation with the canonical variate (Thompson, 1984). The result shows that private commercial agencies (loading 0.9390) are favored over governmental and web-based intermediaries by European firms when they are seeking competences in technology transfer to China. By favoring private commercial intermediaries, European firms pay most attention to networks of potential licensees in China (loading 0.9390). The competences that European firms are looking for when choosing a technology intermediary for technology transfer to China are knowledge of the Chinese legal system, Chinese culture and transaction costs (loadings of 0.6732, 0.6543 and 0.6371, respectively). Industry-specific knowledge has an insignificant effect (loading 0.5417). To test the robustness of this result, we used a split-half approach, which confirmed the canonical correlations observed from the full sample.

Because of the limited sample size, other data sources were sought to triangulate the findings. A recent comparative study of patent licensing by European and Japanese firms (based on an OECD survey of 600 European companies and 1600 Japanese companies) has shown that the major obstacles for European firms in out-licensing their technologies are difficulties in finding partners, problems in concluding licensing deals and high transaction costs (Zuniga and Guellec, 2009). The result of this paper, then, is precisely in line with the OECD study and provides extra insight into which types of technology intermediaries are most favored to overcome these obstacles. In addition to the general findings of the OECD report, the findings in this paper also suggest that, in cross-national patent licensing, providing a deep understanding of Chinese culture and institutions is as important as helping European firms to overcome obstacles in finding partners through networks and reducing transaction costs.

Discussion and conclusions

The findings reveal the preferences of European technology firms considering transferring technologies to China. Private commercial intermediaries are preferred over governmental agencies and web-based marketplaces to extend the competences of European technology firms. This may be because technology transfer to China requires specialized knowledge and deep understanding of the Chinese market and institutional environment, which is beyond the focus of governmental agencies and beyond the reach of web-based marketplaces. Governmental agencies are usually responsible for executing innovation policies and providing incentives (van der Meulen and Rip, 1998), while web-based marketplaces are not able to provide transaction-specific assistance for technology providers and seekers (Lichtenthaler and Ernst, 2008a). This preference for private commercial intermediaries can be further explained in terms of the competences that European firms seek. This study shows that European firms are interested in intermediaries providing competences to expand their own networks of technology recipients, to facilitate their understanding of the Chinese legal system and culture, and to help them reduce transaction costs. Governmental agencies are not meant for these purposes and web-based marketplaces sometimes even increase transaction costs through their asymmetric

approach of match-making (Lichtenthaler and Ernst, 2008a). An additional factor to note is that, because of the incomplete legal system, local protectionism, corruption and intertwined political and economical power exchange, it is critical to utilize *guanxi*, which can only be cultivated through experience (Luo and Park, 2001). For those European firms that are new to the Chinese market, the only way to utilize *guanxi* is through localized intermediaries with extensive experience.

This study also reveals some interesting implications for managers. First, with a greater understanding of the preferences of European technology firms, intermediary agencies may reconsider the services they render. For instance, the web-based market could well combine large networks of both technology providers and seekers with such complementary value-added services as customizing intellectual property rights transaction contracts, *ex ante* and *ex post* evaluation of technologies, etc. Private commercial intermediaries should aggressively extend and deepen their networks in China in order to serve the needs of European technology providers. Innovation policy should make allowances for the different types of intermediaries in order to facilitate technology transfer and innovation diffusion in innovation systems.

This study certainly has its limitations. First, the size of the sample is too small to perform advanced statistical analysis. The small sample size also makes it difficult to control for the influences of industry differences in Europe. Second, the paper identifies the roles of intermediaries based on missing competences of technology-providing firms. It is reasonable to believe that the competences of technology-seeking firms might be different from those of technology providers. Therefore, future research from the perspective of the technology recipient might provide insights that are complementary to the findings of this study. Furthermore, the sample is not representative of firms from Central and Eastern European countries that have joined the European Union recently. Despite these limitations, the findings of the current study should encourage scholars to analyze in greater depth the role of technology intermediaries in technology transfer between the EU and China. Future research with a larger sample, comparing conceptual and behavioral differences in the role of intermediaries among several developing countries, or investigating reverse technology flow from developing countries back to Europe, could deliver interesting results. It would also be interesting to explore the networks of technology providers, seekers and corresponding technology intermediaries using social network analysis to investigate the role of social capital embedded in such networks.

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Appendix. Online questionnaire

1. Future intermediary

How much would you be interested to make use of the following intermediaries if you were to be active in technology transfer to Chinese organizations in China in the future? (five-point Likert scale)

Governmental/public intermediary agency

Private commercial agency

Web-based intermediary

2. Factors in choosing an intermediary

How important are statements below to you in choosing an intermediary for technology transfer to Chinese organizations in China? (five-point Likert scale)

Network

The intermediary has an extensive network of potential licensees/recipients

The intermediary can provide us with critical information through its network

Reduction of Transaction Costs

The intermediary actively seeks potential licensees/recipients

The intermediary actively checks the credibility of potential partners

Personal relationships with the intermediary

Industry

The intermediary has specific knowledge on my industry

The intermediary has specific knowledge on industries related to my industry

The intermediary has specific knowledge on the technologies in my industry

China Specific

The intermediary has extensive knowledge of the Chinese culture

The intermediary has extensive knowledge of the Chinese legal system