

Technology-sourcing investment abroad as an enhancer of Chinese MNEs' innovative capabilities

Chinese MNEs' innovative capabilities

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Abstract

Purpose – The purpose of this paper is to focus on Chinese firms' innovation processes that are induced by foreign direct investment abroad. The study uses a patent and citation analysis to examine the extent to which investments abroad contribute to enhancing these firms' innovative capabilities. More specifically, this study focusses on the role of foreign location competitiveness as an asset to provide technological capabilities to Chinese affiliates.

Design/methodology/approach – Patents are good indicators of firms' innovative capabilities. Moreover, patents allow to track the inter-firm knowledge transfer through the citations of patents on which they are based. The authors use an OECD patent database called "OECD REGPAT July 2013" that compiles patents registered with the European Patent Office (EPO) over the period from 1986 to 2013. The authors focus the analysis on patents registered by Chinese multinational enterprises' (MNEs) based in Europe because the authors assume *inter alia* that innovations patented by Chinese affiliates in Europe are registered with the EPO. The sample comprises 3,010 patents involving 5,749 citations that the authors have individually examined.

Findings – The findings suggest that Chinese MNEs ability to generate innovation based on their own knowledge is low, with a self-citation rate of approximately 4 percent. Patents by Chinese MNEs are largely based on foreign patents, especially from developed economies (at least 90 percent). The citation analysis also suggests that 39.2 percent of citations represent domestic firms in the local recipient country. This subgroup of citations is categorized as follows: 1.04 percent are M&A linkages, 13.8 percent are cluster linkages, and 24.36 percent are localization linkages. The remaining 60.8 percent of the total sample demonstrates that firms do not necessarily need to be collocated in foreign locations with domestic firms to exchange assets.

Research limitations/implications – Patent and citation analysis considers only a part of the inter-firm knowledge diffusion. Some innovations are not patented and tacit knowledge diffusion is not observable. Moreover, the analysis focusses only on Chinese outward foreign direct investment to Europe, but a large part of knowledge is accumulated in China thanks to inward foreign direct investment.

Originality/value – Many scholars have scrutinized emerging markets multinational enterprises' strategic asset-seeking investments abroad that are designed to upgrade the companies' technological capabilities (Cui and Jiang, 2009; Zhang and Filippov, 2009; Huang and Wang, 2013; Amighini *et al.*, 2014; De Beule *et al.*, 2014; Nicolas, 2014). However, few studies analyze the results of these strategies in terms of innovation output.

Keywords Knowledge transfer, Chinese multinational firms, Business networks

Paper type Research paper



Introduction

China is one of the leading "emerging markets" that play an increasingly important role in the world economy. Until now, Chinese competitiveness has relied largely on inexpensive labor costs, and Chinese firms are mainly active in mature markets characterized by "standardized technologies" (Wang *et al.*, 2012, p. 434). According to the World Economic Forum (WEF) classification, China belongs to the group of

countries characterized by an “efficiency-driven stage of development” (WEF, 2013, p. 10). The country is still a long way away from joining the cohort of the so-called “innovation-driven economies,” according to the WEF classification (Nolan, 2001). As indicated by Deng (2007), Chinese firms’ innovative capabilities are quite weak, reflecting the country’s poor domestic “innovation system” (p. 77). Thanks to international activities and links with foreign firms, Chinese firms are in the process of enhancing their technological capabilities. For example, Wang *et al.* have identified positive relations between external technology acquisitions (e.g. through licensing agreements) and Chinese firms’ performance (Wang *et al.*, 2013, p. 1082). Earlier studies have also addressed the role of trade and investment flows to acquire new knowledge and innovative capacities (Wei and Liu, 2006; Guan *et al.*, 2006; Liu and Buck, 2007).

In this respect, inward and outward foreign direct investment (IFDI and OFDI, respectively) may play a significant role in strengthening the innovative capabilities of Chinese firms. China has been among the main recipient countries of FDI and among the main investors abroad over the last few years (UNCTAD, 2013, pp. 3-6). In 2012, China jumped from 6th to 3rd place as the largest investor (annual flows) after the USA and Japan (UNCTAD, 2013, p. xiii). Although Chinese OFDI stocks are still limited, China is expected to be one of the major investors in the near future (Wu and Chen, 2001; Alon *et al.*, 2010, p. 14; UNCTAD, 2013, p. 21). Many early studies on Chinese OFDI have highlighted the fact that most Chinese investors abroad were mainly market seekers and resource seekers (Alon *et al.*, 2012). However, more recently, Chinese investments, in particular via mergers and acquisitions (M&As) in developed economies, have highlighted the willingness of Chinese firms to tap into competitive assets from the West, such as brands and knowledge (Wu and Ding, 2009; Sun *et al.*, 2012; Rui and Yip, 2008; Amighini *et al.*, 2014). Firms from emerging markets consider FDI to be one of the most effective ways to access and develop strategic assets (Deng, 2009, p. 74; Makino *et al.*, 2002, p. 404). Since the beginning of the 2000s, within the framework of the “go global” strategy, the Chinese government has been encouraging FDI in R&D activities abroad to help Chinese firms obtain foreign technologies and enhance their technological capabilities (Wu and Ding, 2009, pp. 174-175; Rugman *et al.*, 2014). As highlighted by Huang and Wang (2013, p. 100), this strategy has been driven by a willingness to be more competitive both in international markets and at home. This “double” spectrum of strategic asset-seeking investment abroad has to be taken into account to understand the types and locations of Chinese firms based in foreign countries.

The literature on international business provides many theoretical and empirical studies on the role of FDI as a vehicle to acquire technologies and knowledge capabilities in host countries (Dunning and Lundan, 2008, pp. 551-605). Many scholars have scrutinized emerging markets’ MNEs’ (EMNEs) strategic asset-seeking investments abroad that are designed to upgrade their technological capabilities (Cui and Jiang, 2009; Zhang and Filippov, 2009; Amighini *et al.*, 2014; De Beule *et al.*, 2014; Huang and Wang, 2013; Nicolas, 2014). However, few studies have examined the results of these strategies in terms of innovation capabilities obtained through strategic asset-seeking investments abroad (Park and Choi, 2014, pp. 104-105). This paper tries to fill this gap by examining the innovation process within Chinese firms and, more precisely, by analyzing the extent to which investments abroad may contribute to enhancing Chinese firms’ innovative capabilities. The study comprises four parts. The first part considers the role of strategic-asset seeking investments as a decisive tool to strengthen the innovative capacity of Chinese investors. The second part addresses the major

investment modes chosen to operate strategic asset investments abroad. The third part links these modes of entry to the internal and external network organization of the firms. The fourth part analyzes the sources of the Chinese firms who have operated FDI in Europe. We use an OECD patent database called “OECD REGPAT July 2013” that compiles patents registered with the European Patent Office (EPO) over the period from 1986 to 2013. We concentrate our analysis on patents registered by Chinese MNEs based in Europe because we assume *inter alia* that innovations patented by Chinese affiliates in Europe are registered with the EPO. The sample comprises 3,010 patents involving 5,749 citations that we individually scrutinized. We focus our analysis on patents because they reveal the sources, or citations, on which an innovation is based (Cantwell and Mudambi, 2011, p. 209).

Chinese strategic asset-seeking investments abroad

International strategies aimed at accessing foreign technologies abroad have been studied mainly through the theory of the internationalization of R&D activities (Dunning and Narula, 1995; Kuemmerle, 1997, 1999; Michel, 2009; Yip and McKern, 2014). Contributions to the internationalization of R&D activities have been particularly numerous since the beginning of the 1990s (Kogut and Zander, 1993; Birkinshaw, 1996; Kuemmerle, 1997; Mudambi and Navarra, 2004; Cantwell *et al.*, 2004; Criscuolo, 2004; Rao *et al.*, 2012). Most of these contributions have concentrated on developed economies' multinational enterprises (MNEs) because MNEs were largely involved in R&D internationalization activities. In addition to the “traditional motivations” to invest abroad (market seeking, resource seeking, and efficiency seeking), strategic asset-seeking investments are particularly important for “innovation-driven economy” MNEs, whose main competitive advantages rely on their ability to innovate and continuously create new strategic assets (Dunning and Narula, 1995; Dunning, 1998, p. 50; Gugler *et al.*, 2013, p. 3). Strategic assets may be defined as knowhow, knowledge, experience, capabilities, and resources that contribute to the FSA (Deng, 2009, p. 74).

Recently, the MNEs of emerging markets have embarked on strategic asset-seeking investments abroad, particularly in knowledge-intensive industries (De Beule *et al.*, 2014; Holtbrügge and Kreppel, 2012; Zhang and Roelfsema, 2014). Chinese MNEs have been increasingly involved in strategic asset-seeking FDI since the beginning of the 2000s (Wu and Ding, 2009, p. 175). This phenomenon has been studied from different perspectives based on the “industry-based view” (industry pull and push effects), the “resource-based view” (“asset exploiting” vs “asset seeking”), and the “institution-based view” (“home institutions” vs “host institutions”) (see Cui and Jiang, 2010, pp. 753-754; Wang *et al.*, 2012; Gaur *et al.*, 2014; Rugman *et al.*, 2014). The motivations and modes of entry for FDI have been investigated in detail (Buckley *et al.*, 2007; Child and Rodrigues, 2005; Deng, 2007; Alon *et al.*, 2012; Gaffney *et al.*, 2013). Regarding the motivations of Chinese FDI, recent studies have focussed on numerous market-seeking investments, particularly in developed economies and, to a lesser extent, in emerging markets, as well as on resource-seeking investments, particularly in developing countries, such as in Africa (e.g. Alon *et al.*, 2012; Bräutigam and Tang, 2014). Chinese strategic asset investments in developed economies have raised significant interest because they reflect a new dimension of competition in world markets. A recent survey published by the European Chamber of Commerce in China (2013) – analyzed by Nicolas (2014, p. 111) – shows that strategic asset-seeking investments in the European Union are the second most important motivation for Chinese firms to invest in Europe. These new

developments are of great importance because they challenge the theory of international business and offer new perspectives to apply and complement the main theoretical streams regarding FDI (Dunning *et al.*, 2008; Ghauri and Santangelo, 2012; Huang and Wang, 2011; Contractor, 2013).

Chinese firms' competitiveness in international markets is mainly based on low costs, mature market goods, and standardized technologies (Wang *et al.*, 2012, p. 434; Zhang and Roelfsema, 2014). Chinese firms have gained competitive advantages related to low production costs for relatively "simple" products (Zhang and Roelfsema, 2014, p. 91). Competing in high-value markets first requires the creation of value and thus the offering of specific and differentiated products to customers via innovation (Porter, 2008, p. 40). However, as noted by several studies, Chinese firms' innovation capabilities are rather weak, which is why most Chinese firms do not compete in highly sophisticated industries (Child and Rodrigues, 2005, p. 389; Rugman and Doh, 2008, p. 151). Whereas Chinese FDI in developing and emerging markets is operated due to existing ownership advantages (Li, 2007, p. 299; Shenkar, 2009, p. 150), strategic asset-seeking FDI in developed economies is mainly driven by competitive disadvantages with regard to firms' innovation capabilities (Child and Rodrigues, 2005, pp. 381 and 388; Cheung and Suny, 2009, pp. 314-315; Cui and Jiang, 2009, p. 434).

Studies on Chinese ownership advantages recognize that the main competitive advantages are based less on FSAs and more on country-specific advantages (CSAs), such as the availability of capital, the direct and indirect support from the government linked to their statutes of state-owned enterprises (SOEs) for the majority of Chinese MNEs, and the strengths arising from the large domestic market (Rugman and Li, 2007, p. 337; Zhang and Filippov, 2009, p. 13; Chen and Young, 2010; OECD, 2008a, p. 77; Deng, 2007, p. 78; Wang *et al.*, 2012, p. 434; Child and Rodrigues, 2005, p. 385; Shenkar, 2009, p. 155; Cui and Jiang, 2009, p. 434; Robins, 2013, pp. 532-533; Huang and Wang, 2013, p. 86). Furthermore, similar to other EMNEs, Chinese MNEs face disadvantages created not only by the so-called "liability of foreignness" but also by the fact that their home country is not a developed economy (De Beule *et al.*, 2014; Cui *et al.*, 2014).

Rugman defines an FSA "[...] as a unique capability proprietary to the organization. It may be built upon product or process technology, marketing, or distributional skills" (Rugman and Li, 2007, p. 334). Several types of firm-specific disadvantages have been identified, such as "limited managerial skills" (Shenkar, 2009, p. 158) and weak knowledge capabilities (Zhang and Filippov, 2009, p. 6; Deng, 2007, p. 77; Rugman and Li, 2007, p. 336; Liu and Buck, 2009, p. 179; Child and Rodrigues, 2005, p. 387; Shenkar, 2009, pp. 157-158; OECD, 2008b, p. 290). Weak Chinese FSAs, particularly their poor ability to innovate and generate new knowledge, constitute one of the major drivers of Chinese strategic asset investment abroad (Deng, 2007, p. 78, 2009, p. 74; Makino *et al.*, 2002, p. 404; Cui and Jiang, 2009, p. 434; UNCTAD, 2006, p. 168; Jiang *et al.*, 2007, p. 2; OECD, 2008b, p. 290; Wei *et al.*, 2004, p. 364). This situation may explain that most strategic asset FDI from Chinese MNEs have been directed toward innovative developed countries (overall high domestic technological CSAs) in sectors where local firms benefit from strong technological FSAs (Liu and Woywode, 2013, p. 471; Wu and Ding, 2009, pp. 173-175; Deng, 2009, p. 14; Makino *et al.*, 2002, p. 404; OECD, 2008a, p. 98ss; Wang *et al.*, 2012, p. 433; Amighini and Franco, 2013, p. 154). This approach – examined inter alia through "the awareness-motivation-capability" framework – reflects the aim to catch-up FSAs' deficits through strategic asset-seeking investment abroad (Cui *et al.*, 2014, p. 488; Meyer *et al.*, 2009).

However, Chinese firms benefit from FSAs in such areas as operational flexibility (Hong and Sun, 2006, p. 633; Chang, 2011; Lyles *et al.*, 2014, p. 7). For example, the dynamism and flexibility of so-called “family firms” constitute specific competitiveness assets that benefit Chinese firms (Erdener and Shapiro, 2005, p. 425). Their “networking capabilities” create a competitive advantage fostering Chinese firms’ FSAs (Yeung and Liu, 2008, p. 33; Buckley *et al.*, 2007, p. 502; Child and Rodrigues, 2005, p. 386). The networking capabilities of Chinese firms may also encourage them to enter into strategic asset investments with the aim of benefiting from local knowledge due to their ability to create tangible and intangible relationships with domestic firms and institutions in the recipient countries (Boisot and Child, 1996, p. 613ss; Erdener and Shapiro, 2005, p. 421).

Operational modes to upgrade innovative capabilities abroad

M&As and, to a lesser extent, Greenfield investments are identified as the main modes of Chinese MNEs’ strategic asset FDI (Deng, 2007, p. 14; Sun *et al.*, 2012, p. 4; Rui and Yip, 2008, p. 213; Shenkar, 2009, p. 154; Nicholson and Salaber, 2013, p. 963; Cui and Jiang, 2010, p. 757). Chinese strategic asset-driven M&A abroad is the dominant strategy to acquire Western partners’ brands, human capital, technologies, and intangible assets while using the CSAs of their home country, offering them institutional and financial support to operate their investments (De Beule *et al.*, 2014, p. 137; Rui and Yip, 2008, p. 214; Zhao and Ordonez de Pablos, 2010, p. 156; Child and Rodrigues, 2005, p. 392; Liu and Buck, 2009, p. 171; see also Globerman and Shapiro, 2009, p. 166; OECD, 2008a, pp. 74-75; Jiang *et al.*, 2007, p. 17). Case studies on major Chinese MNEs, such as BOE, Lenovo, and TCL, have scrutinized the main motivations behind these firms to perform M&As abroad and have confirmed the willingness of Chinese firms to access specific assets abroad to compete with firms from developed countries (Deng, 2007, 2009, pp. 80-88; Liu and Buck., 2009, p. 171; Hong and Sun, 2006, p. 625ss; Li, 2007, p. 304ss; Rui and Yip, 2008, pp. 218-224; Globerman and Shapiro, 2009, p. 166; OECD, 2008a, p. 75).

De Beule *et al.* (2014, p. 148) show that the choice of the degree of EMNEs ownership abroad does not depend on the technological intensity of the industry. According to a study examining 166 Chinese M&As abroad from 2004 to 2006, these M&A operations were “insensitive to industries,” suggesting that “[...] M&A is not considered as the major channel to enhance the firm’s capabilities to innovate and to generate new knowledge. Chinese MNEs’ goal through M&A in developed countries may be to catch-up but less likely to outrace their competitors as major innovators” (Jiang *et al.*, 2007, p. 4). Indeed, Chinese M&As abroad do not succeed in leveraging the innovation capabilities of Chinese firms in most cases thus far (Rugman and Li, 2007, p. 337; Shenkar, 2009, pp. 159-160). According to Rugman and Li, this lack of success may be explained by Chinese firms’ lack of experience in R&D activities, in foreign M&As, and in “internal managerial” knowledge (Rugman and Li., 2007, p. 336). Furthermore, not all Chinese M&A operations pursue a strategic asset-seeking strategy (Cui *et al.*, 2014, p. 489). Because Chinese firms lack high-skilled labor and high-tech knowledge, it is difficult for them to upgrade their innovation capabilities through M&As in foreign countries (Shenkar, 2009, pp. 159-160). At this stage, the effects of M&As on Chinese investors are largely understood as the benefits to exploit the existing knowledge held by Western partners without any technological upgrading (Deng, 2009, p. 83).

M&As are not the sole strategy used to acquire knowledge capabilities in developed economies (De Beule *et al.*, 2014). Greenfield subsidiaries may develop interactions with local firms and institutions in the recipient country. Some interactions may be based on the transfer of codified knowledge, whereas other links relate to exchanges of tacit

knowledge. Several studies have also demonstrated the importance of exchanges of tacit knowledge in the innovation process of co-located firms (Maskell and Malmberg, 1999, p. 172; Asheim and Gertler, 2005, p. 292; Dunning and Lundan, 2008, p. 371). According to Tao *et al.*, the potential for network links with local firms and institutions influences entry decisions and modes of entry in a foreign market (Tao *et al.*, 2013, p. 108).

Some studies have highlighted the role of agglomeration effects with local firms, particularly when the MNEs' affiliates are located within innovative clusters (Jaffe *et al.*, 1993; Audretsch and Feldman, 1996, 2000; Iammarino and McCann, 2006; Tinguely, 2013; Gugler *et al.*, 2013; Kohlbacher *et al.*, 2013; Perri and Andersson, 2014). In this context, the particular role of clusters as important drivers of innovation output based on foreign firms' interactions with members of local clusters has been highlighted by several studies demonstrating the potential fruitful results of MNEs' FSAs with local firms' FSAs, host CSAs, or host region-specific advantages (Birkinshaw and Sölvell, 2000; Tavares Lehmann and Teixeira, 2006; Mudambi and Swift, 2010, Cantwell and Mudambi, 2011; Tinguely 2013). Several studies have described the potential conflicts between the "knowledge creation" objectives of MNEs' affiliates in host countries and "knowledge protection" concerns, or in other words, the willingness of investors abroad to protect their knowledge from undue appropriation by host countries' counterparts (Arikan, 2009, p. 672; Perri and Andersson, 2014, pp. 64-65). This latter concern does not seem to play an important role in Chinese FDI at this stage due to, inter alia, Chinese firms' lack of strong innovative knowhow.

Although most examples are based on MNEs from developed countries (Tinguely, 2013; Gugler *et al.*, 2013), we suggest that Chinese firms are also attracted by externalities created within clusters and innovative regions. For example, a study on Chinese FDI in the automobile sector in 44 foreign countries shows that the Chinese investors were attracted by the "potential spillover" from clusters (Amighini and Franco, 2013, p. 160). Clusters reduced institutional distances and therefore endogenous and exogenous uncertainty, which may attract Chinese firms (De Beule *et al.*, 2014; Yildiz, 2014). Chinese firms are also attracted by the quality of the labor market, whose efficiency is usually better within clusters (Amighini and Franco, 2013). Because knowledge is partially tacit, the role of exchanges within local innovation systems is particularly important for fostering innovation (Cantwell and Mudambi, 2011, p. 209). In this respect, some Chinese MNEs, such as Huawei Technologies, Haier, and ZTE Corporation, have established R&D affiliates within the clusters and innovation centers of host countries (Cui and Jiang, 2009, p. 437; Buckley *et al.*, 2008, pp. 738-739; Poncet, 2007, p. 12). Contractor's study on EMNEs finds a higher propensity of EMNEs to enter into collaboration agreements with host country counterparts due to their cultural and institutional ability to network (Contractor, 2013, p. 313). As indicated above, Chinese firms benefit from FSAs in terms of networking capabilities (Boisot and Child, 1996, p. 623). Therefore, these firms may obtain advantages by locating within innovative regions and prospecting for strategic interactions with local firms and institutions. According to Mathews, investments oriented toward clusters and innovative centers may be explained using the "linkage-leverage-learning" (LLL) model, which states that latecomer firms attempt to obtain competitive advantages through LLL strategies in host countries (Mathews, 2006, pp. 18-20; Li, 2007, p. 299).

Strategic portfolio of Chinese activities abroad

Strategic asset-seeking FDIs are based on a firm's strategy to enhance its knowledge-based competitiveness through optimal interactions between its competitive assets and

the location advantages offered by the host country (Buckley and Casson, 1976; Rugman and Verbeke, 1992, p. 762; Dunning and Lundan, 2008, pp. 72-74; Rugman, 2010, p. 4). Considering the firm as a unit of analysis, the Rugman's matrix based on FSAs and CSAs offers a powerful framework for studies dedicated to strategic asset-seeking investment (see Rugman, 1981). Furthermore, according to this matrix, we may analyze the internal organizational structures and interfirm linkages of specific firms (Collinson and Rugman, 2011, p. 32). MNEs constitute a spectrum of networks that are internal and external to the firm (Rugman and Verbeke, 2001; Noorderhaven and Harzing, 2009; Giroud and Scott-Kennel, 2009; Hallin *et al.*, 2011; Collinson and Wang, 2012; Santangelo, 2012; Verbeke, 2009; Meyer *et al.*, 2011; Rugman *et al.*, 2011). The "competence-creating" activities of MNEs' affiliates are associated with the MNEs' embeddedness in their local networks (Cantwell and Mudambi, 2011, p. 207). MNEs' subsidiary FSAs are linked to the FSAs of local firms collocated within clusters or local innovation systems (Narula, 2013, p. 12).

Recent studies have demonstrated that MNEs' strategic asset investments in specific locations are part of the strategic management of a "knowledge-cluster portfolio" with the aim of enhancing the innovative firm's FSAs (Rugman and Verbeke, 2001, p. 240; Tinguely, 2013; Gugler *et al.*, 2013; Mudambi, 2008, p. 699; Meyer *et al.*, 2011, p. 236). Mudambi notes that "firms can enhance their competitive advantage by dispersing their creative endeavours, tapping into multiple centres of excellence and coordinating knowledge across geographic space" (2008, p. 700). This mechanism combines the external embeddedness of the firm with its internal embeddedness. Internal embeddedness relies on the internal organization of the firm. The types of links among subsidiaries and between the subsidiaries and their headquarters are particularly important for "knowledge transfers," "knowledge-absorptive capacities," and the "knowledge generation" of the firms (Gugler *et al.*, 2013, p. 8; Segarra-Cipres *et al.*, 2014).

As highlighted by recent works on the relationships between subsidiaries and their headquarters, a firm's entities do not necessarily share their experience and knowledge with the other parts of the firm (Narula, 2013; Mudambi *et al.*, 2014; Mudambi, 2011; Najafi-Tavani *et al.*, 2014). As noted by Narula (2013, p. 2), the literature considers two main scenarios regarding the "subsidiary-parent firm" relationship: the traditional "hierarchical" relationship and the "federal" structure (see also, Foss *et al.*, 2012; Park and Choi, 2014). The Chinese model relies more on the "hierarchical" model than the "federal" model. The process occurs within a strong "internal embeddedness" structure due to the robust hierarchical structure of most Chinese firms (for a general discussion regarding the internal embeddedness and external embeddedness of MNEs, see Narula, 2013, p. 8ss). This model may facilitate the institutional transfer of information inside the firm; however, as suggested above, the efficiency of these transfers may be called into question due to the weaknesses of most internal entities with regard to their technological FSAs. Furthermore, as suggested in the previous section, contrary to what has been observed in the case of developed countries' MNEs, such as in the case of Swiss pharmaceutical companies (Tinguely, 2013), it is unlikely that Chinese MNEs benefit from a successful internal management of affiliate networks in terms of exchanging and generating new knowledge developed in different subsidiaries located in different countries (Shenkar, 2009, p. 150). Nevertheless, we suggest that external relationships with local counterparts in developed host countries help Chinese MNEs to generate innovations within individual subsidiaries located abroad. The process is uncertain, and potential positive externalities may take time to be achieved

(Tao *et al.*, 2013, pp. 114-115). However, whereas developed economies' firms may be more reluctant to take risks and engage in long-term results strategies, we may assume that Chinese firms – at least those that have strong links with the government (e.g. SOEs) – may have less concern in this respect and may be more inclined to engage in “network” FDI abroad.

Synthesis and propositions based on a patent analysis

According to the previously described theoretical and empirical thoughts based on the economic literature, our study examines the following propositions regarding the innovation capabilities of Chinese MNEs and particularly the role of FDI in strengthening their ability to generate knowledge:

- (1) Collaborations with foreign firms to upgrade their innovation capabilities are limited. The number of co-owned patents is low.
- (2) The ability of Chinese MNEs to generate innovation based on their own knowledge is low. The patents held by Chinese MNEs that incorporate the knowledge gained from previous patents are largely based on patents developed by other applicants (i.e. the self-citation rate is low).
- (3) The patents held by Chinese MNEs that incorporate the knowledge gained from previous patents registered by other applicants are largely based on foreign patents (i.e. the citation rate of patents registered by other Chinese firms is low). Foreign patents cited in Chinese MNEs' patents are largely registered by firms located in developed economies.
- (4) M&As have a moderate impact on the ability of Chinese MNEs to generate new knowledge based on the acquired or merged foreign firms.
- (5) Network effects contribute to generating new knowledge within the Chinese affiliates located in clusters or innovative centers. Linkages with independent domestic firms and institutions located in the recipient country – particularly within clusters – are significant drivers for generating innovations based on foreign knowledge.

Methodology and data

Methodology

As noted by the OECD (2009, pp. 12-13), patents are frequently used as “indicators of invention and give information on the output and process of inventive activities.” Furthermore, “they provide a detailed description of how the inventions have been made and the prior art” (OECD, 2009, p. 30). These properties are interesting for the analysis and assessment of knowledge transfers. However, patents suffer from drawbacks that must be taken into account in the interpretation of the patent analysis results. As highlighted by the OECD (2009, p. 13), companies operating in different industries and countries can behave differently in the patent process. Strategically, some companies may prefer not to patent their inventions and to transfer knowledge tacitly.

The counting method to determine the number of patents filed by an applicant is fractional, meaning that a patent is weighted by its applicants' shares. In other words, fractional counts allow a number of applicants to share a patent and avoid double counting (OECD, 2009, p. 64). For example, if the same patent is developed and filed jointly by two firms, each firm will get 0.5 share of the patent. A patent filed by multiple

applicants represents a cooperation/collaboration between the applicants to develop the patented invention (OECD, 2009, p. 64). This “co-ownership of patents” indicates that the involved applicants have shared knowledge and other resources (Avidity IP Ltd, 2012, p. 1). Suggesting that Chinese MNEs are strategic – asset seeking, an analysis of the co-ownership of patents, more specifically the localization of the co-applicants, can provide insight into the level of knowledge transfer through collaboration.

Alternatively, patent citations provide information on the knowledge diffusion across firms, industries, and regions or countries (OECD, 2009, p. 31). Thus, we can track the diffusion of knowledge and identify the influence of specific inventions (patents) on new inventions (patents). Such tracking can be accomplished based on “patent citations”: “the use of previous inventions (patents) in new inventions” (OECD, 2009, p. 30). However, patent citations must also be considered with caution because they may provide a “noisy signal” of knowledge flows (Jaffe *et al.*, 1998). Even if the applicant mentions the prior patents on which his patent is based, the patent examiner may include other patent citations. This situation can result in potential knowledge-flow biases because the applicant may not be aware of some contents of the patent citations (Criscuolo and Verspagen, 2008).

The citation indicators provide information regarding the cited firm (i.e. the applicant for the patent on which a Chinese patent is based): name, localization, operating sector, and link with the citing firm (e.g. operations in the same country, same region, same cluster, or linked through an M&A). It is worthwhile to distinguish self-citations and citations of patents from other firms. As noted by the OECD (2009, p. 113), “citations to patents that belong to the same applicant (self-citations) mostly represent internalized transfers of knowledge, whereas citations to other patents are closer to diffused spillovers.” Self-citations allow us to evaluate the ability of firms to innovate, whereas citations of patents from other firms allow us to assess the importance of knowledge spillovers.

Using a descriptive statistical method of patents and patent citations, we assess the significance of knowledge spillovers for some Chinese MNEs in their European investments.

Data sample

Our sample is based on patents registered by Chinese MNEs with the EPO over the period from 1986 to 2013. Because our objective is to understand whether Chinese MNEs invest in Europe to benefit from knowledge transfers, we consider Chinese MNEs listed on the Shanghai Stock Exchange that have undertaken investments in European countries. Among these Chinese MNEs, 24 firms are identified as applicants (i.e. firms that have registered a patent with the EPO) in the OECD patent database called “OECD REGPAT July 2013,” which lists all of the patents filed with the EPO. These firms registered 3,010 patents with the EPO over the period considered and cited 5,749 other patents on which their own patents are based (see Table I).

Table I presents the 24 Chinese firms considered in our sample. For each firm, the table indicates its industrial sector (two-digit SIC code), the number of patents registered, the number of citations included in the patents registered, and the percentage of citations of the entire sample. The citation indications are based on the EPO web site (www.epo.org/searching/free/espacenet.html), which provides a list of the patents published worldwide with related information, including their citations.

The sample comprises the four Chinese firms listed in the ranking of the 50 most innovative companies in 2010 (Bloomberg, 2010): BYD (8), Haier (27), Lenovo (29), and

Company name	Sector (SIC-2 digits)	Number of patents	Number of citations	% of total citations
Angang Steel Company Ltd	Primary metal industry	2	7	0.12
Baosteel Group Corporation	Primary metal industry	11	6	0.10
Blue Star Silicone	Chemicals and allied products	3	16	0.28
Byd Company	Electronic and other electrical components	85.5	456	7.93
China International Marine Containers Group	Fabricated metal products	13.5	40	0.70
China Mobile Communications Corporation	Communications	20	24	0.42
CITIC Group	Depository institutions and real estates	6.5	10	0.17
Chongqing Lifan Industry	Transportation equipment	1	5	0.09
Founder Electronics	Business services	1	1	0.02
Gree Electric Appliance	Electronic and other electrical components	5	9	0.16
Guangzhou SAT Infrared Technology (SATIR)	Electronic and other electrical components	3	14	0.24
Haier Group	Electronic and other electrical components	3.5	8	0.14
Hisense	Miscellaneous repair services	2	3	0.05
Huaqi	Miscellaneous repair services	1	1	0.02
Huawei Technologies Co. Ltd	Business services	2,076	4,450	77.40
Lenovo Group Ltd	Industrial and commercial machinery and computer equipment	26.5	60	1.04
Petrochina	Oil and gas extraction	7	14	0.24
Sany	Automotive repair, services and parking	6	19	0.33
Sinochem International	Wholesale trade – nondurable goods	1	3	0.05
Sinopec	Oil and gas extraction	105	341	5.93
Suntech Power Holdings	Electronic and other electrical components	1	2	0.03
TCL – Alcatel/Thomson	Motion pictures	28	86	1.50
Wuhan Guide Infrared	Electronic and other electrical components	2	4	0.07
ZTE	Business services	600	170	2.96
Total		3,010.5	5,749	100

Table I.
Firms included in the total sample, number of filed patents at EPO and citations

China Mobile Communications Corporation (44). However, the number of patents registered with the EPO by these four companies is relatively small. These companies do not systematically register all of their discoveries with the EPO. Of the Chinese firms considered here, Huawei has registered the largest number of patents with the EPO (approximately 80 percent of the patents identified in our sample). As a result, Huawei also registers the largest number of citations (approximately 77 percent). Therefore, we must interpret our results with caution due to this potential bias.

Results

1. *The number of co-owned patents (or co-patents) is low, suggesting a low level of knowledge transfer through collaboration*

Table II reports a low number of co-patents. Only 47 patents were filed by more than one applicant and therefore have an applicant share between 0 and 1. The localization of the co-applicants indicates that Chinese firms primarily cooperate with other Chinese firms (76.6 percent). Collaborations with European firms represent 12.8 percent, whereas collaborations with US firms account for 6.4 percent of co-applicants.

2. *The ability of Chinese MNEs to generate innovation based on their own knowledge is low. The patents held by Chinese MNEs that incorporate the knowledge contained in previous patents are largely based on patents developed by other applicants (i.e. the self-citation rate is low)*

Table III illustrates the small percentage of self-citations identified in the database. On average, only 3.8 percent of our total sample of citations is self-citations, whereas 4.5 percent of the sample is self-citations when Huawei's citations are excluded. This result suggests that Chinese firms develop their own technology mainly through the incorporation of the knowledge held by other firms rather than on their own knowledge, which appears to be limited. A study by Jaffe and Trajtenberg (1999) reports the fraction of citations that are self-citations for different countries. In 1993, the average fraction of self-citations in the USA was approximately 30 percent, whereas this fraction was approximately 20 percent in Great Britain, France, Germany, and Japan. Sampat (2005) finds a self-citation rate of 11 percent for the USA for the 2001-2003 period.

Self-citations have been excluded in the subsequent patent analyses given that the aim of this study is to track knowledge transfers sourced from third parties.

3. *The patents held by Chinese MNEs that incorporate the knowledge contained in previous patents registered by other applicants are largely based on foreign patents (i.e. the citation rate of patents registered by other Chinese firms is low). Foreign patents cited in Chinese MNEs' patents are largely registered by firms located in developed economies*

Our results demonstrate that Chinese patents are largely based on patents held by firms in industrialized countries.

Country of co-applicants	Number of co-patents	Share of co-patents by country (%)
AU	1	2.1
CN	36	76.6
DE	2	4.3
FR	1	2.1
HK	1	2.1
SE	1	2.1
SE/JP/FR/DE	2	4.3
US	3	6.4
Total	47	100.0

Notes: AU, Australia; CN, China; DE, Germany; FR, France; HK, Hong Kong; SE, Sweden; JP, Japan; US, USA

Source: Own calculations based on OECD REGPAT July 2013

Table II.
Localization of
co-patents

Table III.
Self-citations

Company name	No. of citations	No. of self-citations	% self-citations
<i>Total sample</i>			
Angang Steel Company Ltd	7	0	0.0
Baosteel Group Corporation	6	1	16.7
Blue Star Silicone	16	0	0.0
Byd Company	456	4	0.9
China International Marine Containers Group	40	3	7.5
China Mobile Communications Corporation	24	0	0.0
CITIC Group	10	0	0.0
Chongqing Lifan Industry	5	0	0.0
Founder Electronics	1	0	0.0
Gree Electric Appliance	9	0	0.0
Guangzhou SAT Infrared Technology (SATIR)	14	0	0.0
Haier Group	8	0	0.0
Hisense	3	0	0.0
Huaqi	1	0	0.0
Huawei Technologies Co. Ltd	4,450	163	3.7
Lenovo Group Ltd	60	0	0.0
Petrochina	14	0	0.0
Sany	19	0	0.0
Sinochem International	3	0	0.0
Sinopec	341	46	13.5
Suntech Power Holdings	2	0	0.0
TCL – Alcatel/Thomson	86	0	0.0
Wuhan Guide Infrared	4	0	0.0
ZTE	170	4	2.4
Total	5,749	221	3.8

Table IV presents the citations incorporated in the Chinese patents of our sample (excluding self-citations and citations with insufficient information). Only 2.8 percent of the citations are based on previous patents registered by other Chinese firms. Furthermore, Chinese firms mainly cite patents from the USA (46 percent), Western Europe (25 percent), Japan (15 percent), and Canada (4 percent), and 95 percent of citations originate in the OECD countries. Excluding the citations of other Chinese firms, 98 percent of citations originate in the OECD countries (Table V).

However, as previously mentioned, Huawei biases the results due to its relatively important role in patenting and citing. When excluding Huawei, the remaining firms mainly cite patents from the USA (38 percent), Japan (27 percent), and Western Europe (19 percent) (Table IV). Approximately 91 percent of citations originate in the OECD countries. Excluding the citations of other Chinese firms, 98 percent of citations originate in the OECD countries (Table V).

4. M&As have a moderate impact on the ability of Chinese MNEs to generate new knowledge based on the acquired or merged foreign firms

Table VI demonstrates that 39.2 percent of the citations of Chinese MNEs are related to local firms located in their recipient country. The percentage of citations involving a local firm within the recipient country is at least 50 percent for nine of 24 firms. When excluding Huawei (Table VI), only 18.4 percent of the citations of Chinese MNEs are related to local firms in the recipient country. This information does not indicate that

Country	No. of citations	% citations
<i>(a) Total sample</i>		
US	2,517	45.74
JP	789	14.34
FI	364	6.61
KR	266	4.83
SE	259	4.71
DE	246	4.47
FR	243	4.42
CA	225	4.09
CN	156	2.83
GB	142	2.58
NL	65	1.18
IL	47	0.85
IT	37	0.67
TW	37	0.67
CH	19	0.35
AU	11	0.20
IE	10	0.18
BE	8	0.15
DK	7	0.13
ES	7	0.13
SG	7	0.13
NO	6	0.11
SU	6	0.11
UD	5	0.09
AT	2	0.04
BB	2	0.04
BM	2	0.04
HK	2	0.04
IN	2	0.04
KY	2	0.04
PL	2	0.04
RU	2	0.04
Others	8	0.16
Total	5,503	100.00
<i>(b) Firms without Huawei</i>		
US	474	38.44
JP	332	26.93
CN	85	6.89
DE	69	5.60
FR	48	3.89
KR	48	3.89
FI	38	3.08
GB	30	2.43
CA	24	1.95
SE	20	1.62
NL	14	1.14
TW	13	1.05
IT	11	0.89
CH	6	0.49

(continued)

Table IV.
Localization
of citations

Country	No. of citations	% citations
SU	6	0.49
BE	3	0.24
ES	2	0.16
IL	2	0.16
RU	2	0.16
AT	1	0.08
AU	1	0.08
BR	1	0.08
HK	1	0.08
IN	1	0.08
ZA	1	0.08
Total	1,233	100

Notes: US, USA; JP, Japan; FI, Finland; SE, Sweden; KR, Korea; DE, Germany; FR, France; CA, Canada; CN, China; GB, UK; NL, the Netherlands; IL, Israel; IT, Italy; CH, Switzerland; TW, Taiwan; IE, Ireland; AU, Australia; BE, Belgium; DK, Denmark; SG, Singapore; SU, Soviet Union; NO, Norway; ES, Spain; KY, Cayman Islands; BB, Barbados; BM, Bermuda; BR, Brazil; BS, Bahamas; HK, Hong Kong; IN, India; KHK, Cambodia; PL, Poland; ZA, South Africa. The total number of citations does not include self-citations and citations with a lack of information

Table IV.

Source: Own calculations based on OECD REGPAT July 2013

Country	With Chinese citations		Without Chinese citations	
	No. of citations	% citations	No. of citations	% citations
<i>(a) Total sample</i>				
OECD countries	5,225	94.95	5,225	97.72
Non-OECD countries	278	5.05	122	2.28
Total	5,503	100	5,347	100
<i>(b) Firms without Huawei</i>				
OECD countries	1,121	90.91	1,121	97.65
Non-OECD countries	112	9.09	27	2.35
Total	1,233	100	1,148	100

Table V.
Localization of citations

Source: Own calculations based on OECD REGPAT July 2013

there is a direct link between FDI and the citation of a domestic firm's patent. It is difficult to obtain accurate information on this issue. However, we may assume that a significant part of the citations are linked to the fact that the Chinese firm is located in the recipient country.

Table VI (last column) indicates that Chinese MNEs and the local firms cited are active within the same industry for approximately 89 percent of the citations. This "sectoral relatedness" (Salter and Weinhold, 1979) is not surprising, particularly in the case of strategic asset seekers (Onal, 2009, p. 5). A similar percentage of sectoral relatedness is observed for the sample without Huawei (Table V – last column).

Our analysis distinguishes between the citations of local firms that are part of a M&A and the citations of local firms that are not part of a M&A. As reported above, 39.2 percent of the citations of Chinese MNEs are related to local firms located in their recipient country. This 39.2 percent of "local citations" are categorized as follows: 1.04 percent involve local firms that are part of a M&A, and 38.16 percent involve local

Company name	No. of citations (1)	No. of citations mentioning a domestic firm within the host country (2)	% citations mentioning a domestic firm within the host country (3)	No. of cited firms' sector related to citing firm's one (4)	% cited firms' sector related to citing firm's one (5)
<i>(a) Total sample</i>					
Angang Steel Company Ltd	7	3	42.86	7	100.00
Baosteel Group Corporation	5	0	0.00	4	80.00
Blue Star Silicone	16	6	37.50	15	93.75
Byd Company	448	21	4.69	398	88.84
China International Marine Containers Group	37	1	2.70	24	64.86
China Mobile Communications Corporation	24	10	41.67	22	91.67
CITIC Group	10	0	0.00	8	80.00
Chongqing Lifan Industry	5	0	0.00	5	100.00
Founder Electronics	1	0	0.00	0	0.00
Gree Electric Appliance	9	5	55.56	7	77.78
Guangzhou SAT Infrared Technology (SATIR)	14	10	71.43	14	100.00
Haier Group	8	6	75.00	6	75.00
Hisense	3	2	66.67	3	100.00
Huaqi	1	1	100.00	1	100.00
Huawei Technologies Co. Ltd	4,270	1,930	45.20	3,830	89.70
Lenovo Group Ltd	60	30	50.00	52	86.67
Petrochina	14	5	35.71	13	92.86
Sany	19	10	52.63	19	100.00
Sinochem International	3	2	66.67	3	100.00
Sinopec	291	0	0.00	275	94.50
Suntech Power Holdings	2	0	0.00	2	100.00
TCL – Alcatel/Thomson	86	21	24.42	63	73.26
Wuhan Guide Infrared	4	0	0.00	4	100.00
ZTE	166	94	56.63	156	93.98
Total	5,503	2,157	39.20	4,931.00	89.61
<i>(b) Firms without Huawei</i>					
Angang Steel Company Ltd	7	3	42.86	7	100.00
Baosteel Group Corporation	5	0	0.00	4	80.00
Blue Star Silicone	16	6	37.50	15	93.75
Byd Company	448	21	4.67	398	88.44

(continued)

Table VI.
Domestic citations
within the host
country and sectoral
relatedness

Company name	No. of citations (1)	No. of citations mentioning a domestic firm within the host country (2)	% citations mentioning a domestic firm within the host country (3)	No. of cited firms' sector related to citing firm's one (4)	% cited firms' sector related to citing firm's one (5)
China International Marine Containers Group	37	1	2.70	24	64.86
China Mobile Communications Corporation	24	10	41.67	22	91.67
CITIC Group	10	0	0.00	8	80.00
Chongqing Lifan Industry	5	0	0.00	5	100.00
Founder Electronics	1	0	0.00	0	0.00
Gree Electric Appliance	9	5	55.56	7	77.78
Guangzhou SAT Infrared Technology (SATIR)	14	10	71.43	14	100.00
Haier Group	8	6	75.00	6	75.00
Hisense	3	2	66.67	3	100.00
Huaqi	1	1	100.00	1	100.00
Lenovo Group Ltd	60	30	50.00	52	86.67
Petrochina	14	5	38.46	13	100.00
Sany	19	10	52.63	19	100.00
Sinochem International	3	2	66.67	3	100.00
Sinopec	291	0	0.00	275	94.50
Suntech Power Holdings	2	0	0.00	2	100.00
TCL – Alcatel/Thomson	86	21	24.42	63	73.26
Wuhan Guide Infrared	4	0	0.00	4	100.00
ZTE	166	94	56.63	156	93.98
Total	1,233	227	18.41	1,101	89.29

Notes: (1), Total number of citations by the Chinese firm; (2), number of citations where the Chinese firm cites a firm established in an European host country; (3), ratio (2)/(1) in percent; (4), number of citations where two-dig sector of Chinese firm matches two-dig sector of cited firm; (5), ratio (4)/(1) in percent

Sources: Own calculations based on OECD REGPAT July 2013, Thomson Reuters M&A Database, 2012, web sites of the respective firms

Table VI.

firms that are not part of a M&A (Table VII). According to Table VII, M&As represent 2.64 percent of all citations involving a local firm (= 57/2,157) and only 1.04 percent of all citations (= 57/5,503). The remaining 38.16 percent (of the 39.2 percent of citations that are local) involve Chinese firms that are located in the same recipient country as the cited firms. In the sample without Huawei, 18.4 percent of the citations that are local include 4.6 percent that involve M&A local firms and 13.8 percent that include non-M&A local firms (Table VII). In this case, M&As represent 25 percent of all citations involving a local firm (= 57/227), and the remaining 75 percent of citations involve local firms that are not related to a M&A.

M&As may be an important mode of entry for accessing foreign knowledge, as demonstrated by several studies (Farrell and Shapiro, 2001; Martynova and

Company name	No. of total citations (1)	% citations of local firms (2)	No. of citations of local firms (M&A) (3)	% citations of local firms (M&A) (4)	No. of citations of local firms (no M&A) (5)	% citations of local firms (no M&A) (6)
<i>(a) Total sample</i>						
Angang Steel Company Ltd	7	42.86	3	42.86	0	0.00
Baosteel Group Corporation	5	0.00	0	0.00	0	0.00
Blue Star Silicone	16	37.50	4	25.00	2	12.50
Byd Company	448	4.67	0	0.00	21	4.69
China International Marine Containers Group	37	2.70	1	2.70	0	0.00
China Mobile Communications Corporation	24	41.67	10	41.67	0	0.00
CITIC Group	10	0.00	0	0.00	0	0.00
Chongqing Lifan Industry Founder Electronics	5	0.00	0	0.00	0	0.00
Gree Electric Appliance	1	0.00	0	0.00	0	0.00
Guangzhou SAT Infrared Technology (SATIR)	9	55.56	0	0.00	5	55.56
Haier Group	14	71.43	0	0.00	10	71.43
Hisense	8	75.00	1	12.50	5	62.50
Huaqi	3	66.67	2	66.67	0	0.00
Huawei Technologies Co. Ltd	1	100.00	0	0.00	1	100.00
Lenovo Group Ltd	4,270	45.20	0	0.00	1,930	45.20
Petrochina	60	50.00	30	50.00	0	0.00
Sany	14	38.46	0	0.00	5	35.71
Sinochem International	19	52.63	0	0.00	10	52.63
Sinopec	3	66.67	2	66.67	0	0.00
Suntech Power Holdings	291	0.00	0	0.00	0	0.00
TCL – Alcatel/Thomson	2	0.00	0	0.00	0	0.00
Wuhan Guide Infrared	86	24.42	4	4.65	17	19.77
ZTE	4	0.00	0	0.00	0	0.00
Total	166	56.63	0	0.00	94	56.63
	5,503	39.20	57	1.04	2,100	38.16

(continued)

Table VII.
Decomposition of
the link

Company name	No. of total citations (1)	% citations of local firms (2)	No. of citations of local firms (M&A) (3)	% citations of local firms (M&A) (4)	No. of citations of local firms (no M&A) (5)	% citations of local firms (no M&A) (6)
<i>(b) Firms without Huawei</i>						
Angang Steel Company Ltd	7	42.86	3	42.86	0	0.00
Baosteel Group Corporation	5	0.00	0	0.00	0	0.00
Blue Star Silicone	16	37.50	4	25.00	2	12.50
Byd Company	448	4.67	0	0.00	21	4.69
China International Marine Containers Group	37	2.70	1	2.70	0	0.00
China Mobile Communications Corporation	24	41.67	10	41.67	0	0.00
CITIC Group	10	0.00	0	0.00	0	0.00
Chongqing Lifan Industry Founder Electronics	5	0.00	0	0.00	0	0.00
Gree Electric Appliance	9	55.56	0	0.00	5	55.56
Guangzhou SAT Infrared Technology (SATIR)	14	71.43	0	0.00	10	71.43
Haier Group	8	75.00	1	12.50	5	62.50
Hisense	3	66.67	2	66.67	0	0.00
Huaqi	1	100.00	0	0.00	1	100.00
Lenovo Group Ltd	60	50.00	30	50.00	0	0.00
Petrochina	14	38.46	0	0.00	5	35.71
Sany	19	52.63	0	0.00	10	52.63
Sinochem International	3	66.67	2	66.67	0	0.00
Sinopec	291	0.00	0	0.00	0	0.00
Suntech Power Holdings	2	0.00	0	0.00	0	0.00
TCL – Alcatel/Thomson	86	24.42	4	4.65	17	19.77
Wuhan Guide Infrared	4	0.00	0	0.00	0	0.00
ZTE	166	56.63	0	0.00	94	56.63
Total	1,233	18.40	57	4.62	170	13.79

Notes: (1), Total number of citations by the Chinese firm; (2), report of column 2 from Table VI; (3), number of citations where the Chinese firm cites an acquired firm established in an European host country; (4), ratio (3)/(1) in percent; (5), number of citations where the Chinese firm cites a firm established in an European host country (excluding acquired firms); (6), ratio (5)/(1) in percent. The sum of columns (4) and (6) are equal to column (2)

Sources: Own calculations based on OECD REGPAT July 2013, Thomson Reuters M&A Database 2012, web sites of the respective firms

Table VII.

Renneboog, 2006; Motis, 2007; Wang and Boateng, 2007). The focus of our study is narrower because we examine whether M&As may generate a new innovation based on the existing knowledge held by the local partner. Considering the entire sample, the role of M&As in the ability of Chinese MNEs to generate new knowledge represents a negligible portion of the citations involving a domestic firm located in the recipient country. However, the role of M&As becomes less moderate after removing Huawei and its related bias in the citations.

5. Network effects contribute to generating new knowledge within the Chinese affiliates located in clusters or innovative centers. Linkages with independent domestic firms and institutions located in the recipient country – in particular within clusters – are significant drivers for generating innovations based on foreign knowledge

As indicated in Table VII, approximately 38 percent of citations involve local firms not related to a M&A. These citations represent 97 percent of the citations based on local firms. We have identified Chinese FDI located within clusters. The clusters are identified based on the European Cluster Observatory (2011). The analysis indicates that 30.5 percent of Chinese investments in European countries match a cluster localization. Our results indicate that 759 citations involve domestic firms based in clusters of recipient countries in which Chinese MNEs are located, representing 13.8 percent ($= 759/5,503$) of all citations and 35 percent ($= 759/2,157$) of all citations involving a local firm in the recipient country (Table VII).

Combining the results highlighted in Tables VII and VIII, the analysis indicates that 39.2 percent of the entire sample involves domestic firms located in the recipient country. These citations involve three different sources of knowledge: 1.04 percent represent local firms involved in an M&A with Chinese MNEs; 13.8 percent involve independent local firms located in the same cluster as the Chinese MNEs; and the remaining 24.36 percent involve local firms located in the same region as a Chinese MNE's affiliate but not in a specific cluster.

The remaining 60.8 percent of the sample demonstrates that firms do not need to be collocated to exchange assets (Narula, 2013, p. 12; Santangelo, 2012). As noted by Narula, “[w]here knowledge can be codified, firms can acquire knowledge assets through markets” (2013, p. 12).

Contribution, limitations, and further studies

This paper provides some interesting insights into the strategic asset-seeking motivations of Chinese MNEs to invest in European countries. Using a patent and citation approach, the analysis reveals that the ability of Chinese MNEs to generate innovation based on their own knowledge is low compared to firms from developed countries. This confirms that Chinese firms lack own technological capabilities to innovate. Moreover, as expected, the Chinese innovations are primarily based on foreign knowledge, mainly from firms originating from developed countries. This clearly demonstrates the need to access strategic assets from developed countries. This foreign knowledge can be absorbed through different channels: either through M&A, through greenfields or through establishment in clusters. The two major channels to benefit from knowledge transfers are M&A and establishment in clusters. Rather unexpected, our findings suggest that M&As have a limited effect on the ability of Chinese MNEs to generate new knowledge based on the acquired or merged foreign firms. However, linkages with independent domestic firms and institutions located in

Company name	Sector	Host country	Host region	No. of cited firms in cluster	No. of cited patents
Blue Star Silicone	Chemicals	FR	Ile-de-France/Rhône-Alpes/Aquitaine	1	2
Byd Company	Electronic and other electrical components	NL	South Holland	0	0
China International Marine Containers Group	Fabricated metal products	DE	Hamburg	0	0
Haier Group	Electronic and other electrical components	IT	Veneto	1	1
Huawei Technologies Co. Ltd	Business services	IT	Lazio	1	1
Huawei Technologies Co. Ltd	Business services	DE	Bayern	0	0
Huawei Technologies Co. Ltd	Business services	FR	Ile-de-France	22	348
Huawei Technologies Co. Ltd	Business services	FR	Ile-de-France	0	0
Huawei Technologies Co. Ltd	Business services	SE	Sweden	7	318
Huawei Technologies Co. Ltd	Business services	FR	Ile-de-France	0	0
Huawei Technologies Co. Ltd	Business services	DE	Nordrhein-Westfalen	2	10
Huawei Technologies Co. Ltd	Business services	TR	Turkey	0	0
Huawei Technologies Co. Ltd	Business services	GB	London	0	0
Huawei Technologies Co. Ltd	Business services	GB	London	25	47
Lenovo Group Ltd	Industrial and Commercial Machinery and Computer Equipment	DE	Bade-Wurtemberg	1	1
Lenovo Group Ltd	Industrial and Commercial Machinery and Computer Equipment	FR	Ile-de-France	0	0
Lenovo Group Ltd	Industrial and Commercial Machinery and Computer Equipment	SE	Stockholm	2	4
Lenovo Group Ltd	Industrial and Commercial Machinery and Computer Equipment	SK	Slovakia	0	0
Lenovo Group Ltd	Industrial and Commercial Machinery and Computer Equipment	DE	North Rhine-Westphalia	0	0

Table VIII.
Chinese investments in specific clusters, number of cited firms localized within these clusters and their citations

(continued)

Company name	Sector	Host country	Host region	No. of cited firms in cluster	No. of cited patents
Sinopec	Oil and Gas Extraction	RU	Udmurt Republic	0	0
Suntech Power Holdings	Electronic and other electrical components	IT	Lombardia	0	0
Suntech Power Holdings	Electronic and other electrical components	IT	Lombardia	0	0
Suntech Power Holdings	Electronic and other electrical components	IT	Lombardia	0	0
TCL – Alcatel/Thomson	Motion pictures	FR	Ile-de-France	0	0
ZTE	Business services	SE	Sweden	2	13
ZTE	Business services	GB	South East (UK)	2	2
ZTE	Business services	SE	Sweden	0	0
ZTE	Business services	DE	Nordrhein-Westfalen	0	0
ZTE	Business services	DE	Bayern	2	6
ZTE	Business services	DE	Nordrhein-Westfalen	0	0
ZTE	Business services	FR	Ile-de-France	3	6
ZTE	Business services	DE	Nordrhein-Westfalen	0	0
ZTE	Business services	AT	Vienna	0	0
ZTE	Business services	IT	Lazio	0	0
ZTE	Business services	PL	Masowian	0	0
ZTE	Business services	RO	South Romania	0	0
ZTE	Business services	ES	Madrid	0	0
ZTE	Business services	TR	Marmara	0	0
ZTE	Business services	GB	London	0	0
			Total	71	759

Note: The last two columns correspond respectively to the number of cited firms established in the specific region where the Chinese firm has invested, and to the total number of their patents cited by the Chinese firm

Sources: Own elaboration based on European Cluster Observatory (2011), European Patent Office (2012), M&A Thomson-Reuters Database 2012, OECD REGPAT July 2013, and own observations

Table VIII.

the recipient country, particularly within clusters, are a significant driver for generating innovations based on foreign knowledge.

Nevertheless, our findings have to be interpreted with caution. Some empirical limitations may diminish the robustness of our results. First, due to the small sample of Chinese firms analyzed, our findings cannot be generalized to all Chinese firms investing in European countries and can result in some important biases among firms regarding patenting and citing behaviors. To generalize our results, the analysis should be extended to patents registered with the US Patent and Trademark Office (USPTO) on a larger sample. Second, patents refer to codified knowledge and represent only a portion of the knowledge of a firm. Some discoveries are not patented and can be shared tacitly. The strategic asset-seeking motivation cannot be optimally and efficiently tested using patent analysis because some industries have a higher propensity to patent than others. The citation analysis is useful for study the transfer of knowledge. However, citations are not always registered by applicants. Patent

examiners can add citations unbeknownst to applicants. The last empirical difficulty is to correctly define the link (either an M&A or localization) between the citing and cited firms due to the non-exhaustive list of Chinese investments in European countries.

Based on our research, it would be interesting to investigate the subsidiary-headquarter relationship, scrutinizing the paths of innovation within the firm's network. As noted by Najafi-Tavani *et al.* (2014, p. 123), "[w]hile the literature suggests that it is important to look at subsidiary-headquarters relationships when investigating subsidiary influence (Birkinshaw *et al.*, 2005), this association has not been empirically investigated." The analysis could also investigate the role of subsidiaries within MNEs according to the distinction made by Mudambi *et al.* (2014, p. 103) between the "functional power" and "strategic power" of subsidiaries. Furthermore, this study focusses on assets obtained, upgraded, or created by Chinese affiliates in their European host countries and does not consider the spillovers created by these affiliates in their host countries. It would be worthwhile to analyze more deeply these effects, as in Giuliani *et al.* (2014).

Finally, this paper focusses on the role of Chinese OFDI as vehicle to upgrade firms' innovative capabilities. The study does not address the role of IFDI in China in providing positive technological externalities to domestic firms. As highlighted inter alia by Mathews (2002) and more recently by Zhang and Roelfsema (2014), linkages with foreign affiliates doing business in China may also be an important piece of the global puzzle governing Chinese firms' strategies abroad and their success in acquiring competitive assets abroad.

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