

Outward Foreign Direct Investment and Domestic Innovation Performance: Evidence from China

Abstract:

Recent years have witnessed substantial outward foreign direct investment (OFDI) from many emerging economies. Should the governments of these economies encourage OFDI in order to promote domestic innovation? Much OFDI by emerging economy multinational enterprises (EMNEs) has been undertaken to acquire strategic assets overseas, but do these acquisitions bring innovation benefits at home? The empirical analysis presented in this paper considers the effects of OFDI on regional innovation performance, using a panel of Chinese provinces, and finds that OFDI has a very significant impact on domestic innovation. Furthermore, we also identify three contingent factors - absorptive capacity, foreign presence, and the competition intensity of the local market - that moderate the impact of OFDI on innovation performance.

1 Introduction

Much has been written about the positive impact of inward foreign direct investment (IFDI) on the innovation performance of *host* economies (Ben Hamida, 2013; Ben Hamida & Gugler, 2009; Buckley, et al., 2002; Dunning & Lundan, 2008; Fu, 2012; García, et al., 2013; Iwasaki & Tokunaga, 2014; Ouyang & Fu, 2012; Xu & Sheng, 2012). In contrast, very few studies have considered the impact of outward foreign direct investment (OFDI) on the innovation performance of *home* economies, especially in the context of investments made by multinational enterprises based in emerging economies (EMNEs) (Deng, 2007; Liu, et al., 2005; Xia, et al., 2014). Yet OFDI flows from emerging economies have risen considerably since the turn of the millennium, and now account for more than one third of global FDI flows (UNCTAD, 2014). Furthermore, there is an extensive literature suggesting that a reasonably large proportion of this OFDI is motivated by strategic asset-seeking (Gammeltoft, et al., 2010; Luo & Tung, 2007; Mathews, 2006), in which case it is reasonable to suppose that this OFDI may have a significant impact upon the innovation performance of the home regions in which EMNEs are based.

This paper considers the impact of OFDI on regional innovation in the context of China. By the end of 2011, China accounted for more OFDI than any other emerging economy and was the third largest source of outward investment in the world (UNCTAD, 2014). Nearly 13,500 Chinese firms had together invested US\$ 425 billion in 178 foreign countries (Commerce, 2012) – and cumulative OFDI from China is predicted to exceed US\$ 5 trillion US dollars by 2020 (He, et al., 2012).

Furthermore, there is considerable evidence to suggest that many Chinese MNEs are active seekers of strategic assets (Chen & Young, 2010; Deng, 2012; Edamura, et al., 2014; Ning & Sutherland, 2012; Ramasamy, et al., 2012; Rugman & Li, 2007; Williamson & Yin, 2012) and technology (Chen & Tang, 2014) overseas. China therefore provides an appropriate context to explore the link between OFDI and innovation performance.

The paper draws upon international business (IB) theory and regional innovation systems (RIS) theory. It focuses on the reverse knowledge transfers associated with Chinese OFDI, specifically exploring how domestic Chinese regional innovation performance is affected by OFDI and the factors that moderate this relationship. We contribute to the existing literature in three ways. Firstly, we provide evidence for potential reverse knowledge transfers derived from OFDI by EMNEs, highlighting the positive influence of overseas investment on domestic innovation performance. Secondly, we attempt to understand the vital role of domestic absorptive capacity in facilitating the assimilation of the knowledge latent in Chinese OFDI. Thirdly, we unravel the interactive relationship between inward and outward FDI as well as the importance of competition intensity in the local market in affecting reverse technology transfers effected through OFDI.

The paper is organised as follows. In section 2, we review the relevant literature, and develop seven hypotheses for empirical testing. In section 3, we describe the dataset and the regression model specification, explain the estimation methodology, summarise how the dependent and explanatory variables are

operationalised, and present some descriptive statistics. The regression results are presented and discussed in section 4. The final section summarises the findings of the study, outlines the practical implications, and highlights the limitations.

2 Literature Review & Hypothesis Development

There is a considerable literature suggesting that innovation performance varies not just between nations, but also between sub-national regions, such as states or provinces (see, for example, Acs, et al. (2002), Evangelista, et al. (2001), Fritsch (2002)). This is because knowledge generation and new technology development tend to be spatially-clustered or centralized (Li, 2009) and knowledge and technical capabilities geographically-bounded, meaning knowledge spillovers tend to be localised (Breschi & Malerba, 1996; Cantwell & Iammarino, 2000; Cooke, et al., 1997; Cooke, et al., 1998a; Howells, 1999; Jaffe, et al., 1993; Meyer-Krahmer, 1985). This is particularly the case in the circulating of tacit knowledge (Breschi & Lissoni, 2001; Cantwell & Iammarino, 2003; Howells, 2002; Krugman, 1991; Paci & Usai, 1999). The uneven distribution of innovative activity, moreover, is particularly apparent in many emerging economies, such as China (Sun & Liu, 2010; Wang & Lin, 2013; Yang & Lin, 2012).

The underlying reasons for the regional nature of innovation activities are the subject of RIS theory. Cooke, et al. (1998b: 1564) define RIS as systems “in which firms and other organizations are systematically engaged in interactive learning through an institutional milieu characterized by embeddedness”. Iammarino (2005:

499) adds that RIS constitute “the localised network of various actors and institutions in different sectors whose activities and interactions generate, absorb, and diffuse new technologies within and outside the region”. RIS theory is particularly appropriate when examining the determinants of innovation performance in the context of countries which cover huge geographical areas and where, commonly, there are substantial regional disparities in terms of economic and/or innovative capabilities (Fu, 2008; Yang & Lin, 2012).

The extant literature has identified several drivers of regional innovation performance. For example, the amount of investment in R&D is recognised as the main input in the knowledge production process (Griliches, 1990). Others have also found that regional intelligence (measured in terms of knowledge workers) is a strong direct and indirect driver of regional innovation (Sleuwaegen & Boiardi (2014). Cornett (2009) argued that organizational and functional aspects of a knowledge-based regional development policy are worthy of consideration, since they can be conducive to stimulating innovative behaviour in local industrial sectors.

In the context of China, innovation performance has increased dramatically since the mid-1990s. Patent figures published by the World Intellectual Property Organization (WIPO), for example, show that per capita patent applications in China increased nearly 13 times between 1995 and 2007 (Li, 2012). This dramatic increase helped China become the third-ranked nation worldwide (behind the United States and Japan) for global patenting and surpassing Korea as Asia’s largest patenting force. Hu and Jefferson (2009) suggested that R&D intensity accounted for part of

this improvement in innovative performance. They also found that inward FDI, ownership reform and a stronger legal system also contributed to the surge of patent applications. More recent research has focused on explaining not just the very rapid development of national patenting activity in China, but also the growing regional disparities (Li, 2009; Sun & Liu, 2010; Yang & Lin, 2012). Li (2009), for example, points to regional subsidy programmes¹ implemented by Chinese provinces and municipalities as a critical facilitator for the growth of regional patenting activity. Despite this growing interest in China's RIS, few studies have yet considered the effects of Chinese OFDI on regional innovation performance through reverse knowledge transfers or how OFDI interacts with regional factors, such as domestic absorptive capabilities, inward FDI and local competition

2.1 Outward Foreign Direct Investment from the Domestic Economy

It is customary in the IB literature to classify OFDI as either natural resource seeking, market seeking, efficiency seeking, or strategic asset² seeking (Dunning & Lundan, 2008). Numerous authors have suggested that strategic asset seeking is an important motivation for many EMNEs, and more particularly for Chinese MNEs (Child & Rodrigues, 2005; Deng, 2009; Luo & Tung, 2007; Mathews, 2006). Child & Rodrigues (2005) and Mathews (2006) argue that Chinese firms may not be exploiting

¹ Since 1998, an increasing number of provincial governments began to launch and implement pro-patent policies that encourage patenting through deductions and reimbursements of patent application fees.

² Strategic assets are defined as “the set of difficult to trade and imitable, scarce, appropriable and specialized resources and capabilities”. Such assets are often intangible (Amit & Schoemaker, 1993).

existing competitive advantages when undertaking OFDI, but may rather be trying to address their own competitive disadvantages. Furthermore, Rui & Yip (2008) assert that cross-border acquisitions are often used by Chinese firms to acquire strategic assets to compensate for their competitive disadvantages, while simultaneously leveraging their own distinctive ownership advantages.

Indeed it has been suggested that many Chinese MNEs pursue developed market acquisitions primarily to repatriate intangible strategic assets to their *home* markets. In other words, Chinese MNEs do not primarily look to compete directly in other foreign markets. Rather, they undertake OFDI to exploit acquired intangible strategic assets (technologies, brands etc.) in their large but increasingly competitive *domestic* market (Child & Rodrigues, 2005; Luo & Tung, 2007; Ramamurti, 2012; Rui & Yip, 2008). Ramamurti (2012), for example, notes the potential importance of foreign acquisitions for the purposes of domestic market exploitation. There is also a considerable literature, albeit mainly concerned with MNEs from advanced economies, testifying to the reverse knowledge transfer effects associated with OFDI (e.g. Ambos, et al. (2006); Yang, et al. (2008); Rabbiosi (2011)). Our first hypothesis is thus:

H1: OFDI has a positive impact upon domestic innovation performance.

2.2 Absorptive Capacity in the Domestic Economy

The concept of *absorptive capacity* refers to the ability of a firm/economy to recognise the value of external information, assimilate it, and apply it to commercial ends. The concept has been applied not only to firms, but also to national/regional

economies (Bhagat, et al., 2002; Cohen & Levinthal, 1990; Cooke, et al., 1997; Mowery, et al., 1998; Roper & Love, 2006). Borensztein et al. (1998) suggest the incidence of technology spillovers through inward foreign direct investment (IFDI) hinges upon the level of human capital. Similarly, Fu (2008, 2012) argues that embedded tacit knowledge in inward investment is not immediately available for domestic innovators, and that regional innovative performance is unlikely to benefit from IFDI without a certain scientific base and amount of R&D experience. A higher degree of regional absorptive capacity is thus likely to be directly associated with better innovation performance.

In a similar vein, we would argue that the existing stock and quality of R&D expertise (facilities and personnel) will influence the extent to which reverse transfers of knowledge from overseas markets and spillovers to domestic economies take place (Deng, 2007; Durán & Ubeda, 2005; Rui & Yip, 2008). Thus EMNEs must not only acquire valuable strategic assets through their direct investment activities, but also must subsequently be able to adapt and exploit those assets to the benefit of their home economies. Our second hypothesis is thus that regional absorptive capacity is necessary to facilitate fully the realization of the benefits of OFDI for domestic innovation. We thus hypothesise:

H2a: Regional absorptive capacity will have a positive impact upon domestic innovation performance.

H2b: Regional absorptive capacity will positively moderate the relationship between OFDI and domestic innovation performance.

2.3 Inward FDI in the Domestic Economy

Many authors have suggested that the presence of foreign firms has positive effects upon the innovation performance of host economies (Ben Hamida, 2013; Ben Hamida & Gugler, 2009; Buckley, et al., 2002; Dunning & Lundan, 2008; García, et al., 2013; Iwasaki & Tokunaga, 2014). These effects may be realised through various channels in addition to any innovations introduced directly by foreign firms. First, indigenous firms may learn through the imitation (e.g. reverse engineering) of foreign firms' products and technologies. Second, indigenous firms may benefit from labour market turnover whereby skilled workers from foreign affiliates migrate to local firms carrying with them valuable knowledge. Third, there may be a 'demonstration effect' whereby products and technologies developed in foreign markets are observed by indigenous firms and adapted by their own R&D efforts. Fourth, knowledge spillovers may be apparent either horizontally from foreign competitors in the same industry, or vertically through upstream or downstream value-chain linkages from foreign firms to local suppliers/distributors (Buckley, et al., 2007a; Cheung & Lin, 2004; Fu, 2008; Tian, 2006).

The very presence of foreign MNEs thus acts as a spur to indigenous firms who are forced to observe, learn from, and emulate the superior competences of their foreign rivals, and so match their performance (Durán & Ubeda, 2005). For instance, the technological, quality standards and financial standards adopted by foreign MNEs in China have helped Chinese businesses to learn some of the rules of global business. A higher presence of foreign firms in any region is thus likely to be directly associated with better innovation performance. Furthermore, these same effects will

also enable domestic MNEs to make the most of the assets they have acquired through their outward direct investment. We thus hypothesise:

H3a: The greater the inward FDI in the regional economy, the better will be domestic innovation performance.

H3b: Inward FDI will positively moderate the relationship between OFDI and domestic innovation performance.

2.5 Competition in the Domestic Economy

The nature of the relationship between competition and innovation is not clearcut, as there are both positive and negative effects (EBRD, 2014). On the one hand, greater product market competition might be expected to discourage innovation by reducing the likelihood of subsequent rents. On the other hand, firms may pursue innovation if they believe that they will be able subsequently to differentiate their products and/or lower production costs, and that the post-innovation competition allows them to profit from their R&D efforts (Lee, 2009; Porter, 1980; Yiu, et al., 2007). In the emerging economy context of China, we expect the latter effect to dominate and greater competition to lead to more innovations.

As regards the moderating effect of competition on the relationship between OFDI and innovation, we would expect the negative effect to dominate. EMNEs active in highly-competitive domestic markets may have neither sufficient resources nor the time to conduct R&D (Breschi & Lissoni, 2001; Hu et al, 2005), and thus their abilities to assimilate and apply the knowledge acquired through their OFDI activities may be limited (Chen, et al., 2014; Chen & Tang, 2014). Furthermore, the lack of sufficient and robust legal systems to protect intellectual property rights undermines

the intention of many EMNEs to undertake R&D activities, especially for those firms facing high competitive pressures (Luo & Tung, 2007; Rui & Yip, 2008). EMNEs may well be more reluctant to transfer their acquired products and technologies back to their host economies if they operate in competitive markets because of concerns about losing intellectual property, but would be more willing to do so if there was little competition at home. We thus hypothesise:

H4a: The greater the level of competition in the domestic economy, the better will be domestic innovation performance.

H4b: The level of competition will negatively moderate the relationship between OFDI and domestic innovation performance.

3 Data and Methodology

We have chosen China as the empirical setting for this study of the impact of OFDI on domestic innovation for three main reasons. First, China is an example of a large emerging economy, and one which has been involved in substantial outflows of OFDI in recent years. Second, China is a country with many distinct regions (provinces & municipalities) for which the appropriate data are available – this enables an analysis at *regional* level instead of at the more aggregate national level. Third, the Chinese Government has been an enthusiastic supporter of OFDI through its *Go Global* policy (Luo, et al., 2010) – suggesting that it perceives benefits.

The majority of prior studies that focus on the Chinese RIS choose the administrative provincial-level regions as the unit of analysis (Cheung & Lin, 2004; Fu, 2008; Li, 2009; Yang & Lin, 2012). We thus use a balanced panel dataset for 30

provinces and municipalities over the period 2003-2011³. The OFDI data are drawn from the *Statistical Bulletin of China's Outward Foreign Direct Investment*, compiled by the Ministry of Commerce, the National Bureau of Statistics (NBS), and the State Administration of Foreign Exchange of China. The data for innovation and R&D are assembled from *The China Statistical Yearbook on Science and Technology* and *The Database of China Main S&T Index (DCMSTI)*. The *DCMSTI* is supported by the Ministry of Science and Technology of China (MOST). We calculate the competitive intensity of markets using *The China Industry Economy Statistical Yearbook*. Both these publications are compiled by the NBS and the State Intellectual Property Office of China (SIPO).

3.1 Model Specification

In line with many prior studies of regional innovation performance, we base our model on the knowledge production function (KPF) proposed by Griliches (1979):

$$INN_i = a. (RDI_i)^\alpha \quad (1)$$

where $INN_i =$ innovation performance in region i

$RDI_i =$ R&D inputs in region i

This basic model assumes that innovation (the outcome of successful R&D expenditure) is a function of the inputs to the R&D process (Cohen & Levinthal,

³ The 30 provinces and municipalities are: Anhui, Beijing, Chongqing, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Neimenggu, Ningxia, Qinghai, Shaanxi, Shandong, Shanghai, Shanxi, Sichuan, Tianjin, Xinjiang, Yunnan, Zhejiang. Tibet is excluded from the analysis because of the limited availability of data. We use the available lags in 2010 and 2011 as instruments in our GMM estimation model (please see also the *estimation methodology*)

1989). Here we augment the basic model as follows to include our hypothesised and other control variables, viz:

$$INN_{i,t} = A \cdot (RDI)_{i,t}^{\alpha} \cdot (OFDI)_{i,t}^{\beta} \cdot (ABS)_{i,t}^{\gamma} \cdot (IFDI)_{i,t}^{\delta} \cdot (COM)_{i,t}^{\rho} \cdot Z_{i,t}^{\theta} \quad (2)$$

where $OFDI_{i,t}$ = outward FDI from region i in period t

$ABS_{i,t}$ = absorptive capacity of region i in period t

$IFDI_{i,t}$ = inward FDI in region i in period t

$COM_{i,t}$ = competition in region i in period t

$Z_{i,t}$ = vector of control variables for region i in period t

$A, \alpha, \beta, \gamma, \delta, \rho, \theta$ are parameters to be estimated

We take logarithms of both sides of equation (2), and thus the regression model to be estimated takes the form:

$$\begin{aligned} \ln(INN_{i,t}) = & a + \alpha \cdot \ln(RDI_{i,t}) + \beta \cdot \ln(OFDI_{i,t}) + \gamma \cdot \ln(ABS_{i,t}) + \\ & + \delta \cdot \ln(IFDI_{i,t}) + \rho \cdot \ln(COM_{i,t}) + \theta \cdot \ln(Z_{i,t}) + \varepsilon_{i,t} \quad (3) \end{aligned}$$

where

$a = \ln(A)$ and ε_{it} is an independent and identically distributed error term.

Given the double-log formulation of the regression model, the estimated coefficients may be interpreted as elasticities. We will also incorporate additional variables in the model to capture the interaction effects between the hypothesised variables.

3.2 Estimation Methodology

It is worth noting that reverse causation may well generate estimation problems in studies of innovation performance: i.e. the explanatory variables may have an impact upon innovation, but innovation may also have an impact upon some (or all) of the explanatory variables. For instance, OFDI may lead to better domestic innovation

performance, but more innovative firms are also likely to be more involved in OFDI. These endogeneity issues may arise through learning effects, or through the self-selection of better-performing firms. It is therefore necessary to include a lagged dependent variable as a further control. In such circumstances, Ordinary Least Squares (OLS) and within estimators will tend to over-estimate the effects of the explanatory variables and are also unable to address the simultaneity and endogeneity issues.

We thus use the panel data Generalized Method of Moments (GMM) estimation method. This is regarded as an appropriate method for dealing with unobserved heterogeneity, endogeneity, and also situations where the explanatory variables are not strictly exogenous. Furthermore, the GMM method is also suitable for short panel datasets as it allows the use of instruments of first differences as instruments, and exploits more fully the available moment conditions in a finite sample (Blundell & Bond, 2000; Liu, et al., 2014). We use the first difference of the lagged dependent and explanatory variables as instruments and the Hansen's J-test for checking their overall validity. The Arellano-Bond (AR) test is also employed to detect the existence of the first or second order serial correlation.

3.3 The Dependent Variable

The dependent variable is the regional innovation performance (INN), as measured by the natural log of the patent grants per 10,000 inhabitants made each year (Fu, 2008; Paci & Usai, 1999). Not all innovations are patented, but patent counts are the favoured measure used in most previous research because they provide a more

accurate indication of innovation performance than alternative measures such as “new product” sales (Acs, et al., 2002; Choi, et al., 2011; Hong & Su, 2013; Jaffe, et al., 1993; Wang & Lin, 2013). This is because “new products” are often loosely defined, and can be potentially over-recorded by firms in order to gain subsidies in many countries such as China (Li, 2009). Patents also capture both product and process innovation (Fu, 2008; Usai, 2011). Furthermore, the process of patent registration means that data are publicly-available and of guaranteed quality, and the patent documents typically provide useful technological and organizational details (Griliches, 1990). Patent data are often available in longitudinal series and, last but not least, patent counts provide an homogenous and meaningful indicator of innovation performance across countries (Malerba, et al., 1997).

3.4 The Explanatory Variables

Previous studies have considered the innovation process at the firm (e.g. Lin, et al., 2011), sector (e.g. Li, 2011), and regional (e.g. Fu, 2008) levels, and have typically measured the R&D inputs (RDI) using the R&D intensity. The R&D intensity is calculated by dividing the R&D expenditure for the region in any particular year by the GDP of that region, thus taking account of the relative sizes of the regional economies. We consider the proportion of outward FDI flow over GDP of each region as a proxy for the impact of OFDI. We should stress that not all of this OFDI is motivated by strategic asset seeking considerations, and thus likely to stimulate domestic innovation. However, it is not possible to identify the underlying motivations for the OFDI from the available data, and moreover our data are also

aggregated across various firms. These caveats should be born in mind when interpreting the empirical results. Following prior studies (e.g. Buckley, et al. (2002); Tian (2006); Buckley, et al. (2007b), we include the flow of inward FDI (IFDI) to capture the various spillover, demonstration etc effects associated with the presence of foreign firms. We proxy the absorptive capacity (ABS) of each region by calculating the proportion of technical staff (person-year) over the total employees of a region, on the assumption that innovation is a process typically undertaken by highly educated people.

The intensity of competition in each domestic regional market is estimated using a measure developed by Glaeser, et al. (1992) and (Gao, 2004). We first calculated a sector-specific index of competition in each region (c_{ij}) as follows:

$$c_{ij} = \frac{(n_{ij}/r_{ij})}{(n_j/r_j)} \quad (4)$$

where n_{ij} = number of firms in sector j in region i

r_{ij} = sales revenue of the firms in sector j in region i

n_j = number of firms in sector j at the national level

r_j = sales revenue of the firms in sector j at the national level

A high value of the index for any sector-region combination suggests that there are more firms active in that sector-region than nationally, and hence that the level of competition is greater. As our analysis is regional, we average the values of the sector-specific indices within each region to generate an overall index of competition (COM) within each region:

$$COM_i = \frac{1}{n_i} \sum_{j=1}^{n_i} c_{ij} \quad (5)$$

where n_i = number of industrial sectors in region i

There are three control variables. First, the regional GDP growth rate (GDP) was included to control for the development potential and regional demand for innovation (Ouyang & Fu, 2012). We expect innovation performance to be stronger in regions with faster economic growth, both because the population will have the desire and the funds to purchase new products and because firms will have the expertise and the desire to provide those products. Furthermore, we would expect regions with higher growth to have a stronger recognition of intellectual property rights (Jiang, et al., 2011) and better infrastructure, which should also lead to better innovation performance. Second, foreign technology has been a crucial source of advanced knowledge for many developing countries seeking to improve their innovation capabilities (Yang & Lin, 2012). China was a major buyer of foreign technology over the period covered by this study, and it is important to control for this potential determinant of innovation performance (Li, 2011; Wang & Zhou, 2013). We thus include the proportion of foreign technology purchase value over the total value of technology transaction in each region (FTECH), and expect this to be positively related to innovation performance. Third, several authors have suggested that state-owned enterprises may be less interested in innovation than private enterprises, as they typically operate in protected industries such as resource, energy, and national defence (Lin, et al., 1998) and/or have motives other than profit maximisation (Morck, et al., 2008). We thus expect those regions where state-owned enterprises account for high proportions of capital investment (SOE) to exhibit lower levels of innovation. Detailed definitions of each of the variables are provided in Table 1.

***** Table 1 about here *****

3.5 *Descriptive Statistics*

The number of granted patents (INN) nationally in China has risen dramatically over the 2003-10 period, from 182,226 in 2003 to over 814,825 in 2010 – see Figure 1. This national increase has not been mirrored uniformly across the Chinese regions, however, and better innovation performance has been reported in several coastal provinces (e.g. Guangdong, Zhejiang, Jiangsu) – see Figure 2.

***** Figures 1 and 2 about here *****

Similarly there has been a marked increase in outward foreign direct investment (OFDI) from China over the period, rising steadily from US\$ 2.85 billion in 2003 to US\$ 68.81 billion by 2010 – see Figure 1. The most active regions are the coastal provinces and municipalities (e.g. Guangdong, Zhejiang, Jiangsu and Shanghai), though OFDI from some inland regions (e.g. Yunnan and Sichuan) which border foreign countries has risen in recent years – see Figure 3.

***** Figure 3 about here *****

Table 2 provides means, standard deviations and the correlation matrix for all the variables. The mean number of regional patents over our estimation period is 2.7 per 10,000 residents, whilst the mean research intensity is 1.2%. The average annual flow of regional inward FDI is US\$ 65.6 billion, whilst state-owned enterprises accounted

for 45% of capital investment on average. Meanwhile, outward direct investment amounted to 0.13% of GDP over the period. Most of the correlations between the explanatory variables are small, so multicollinearity is not a serious concern – though the correlations between IFDI and SOE is -0.587, and the correlation between RDI and ABS is +0.641. This latter figure appears to confirm our contention that the most R&D intensive regions are those with the most highly educated populations. We used standardized values for the interaction terms (involving OFDI, ABS, IFDI and COM) to avoid possible biases arising from high correlations with the main effects (Belsley, 1984).

***** Table 2 about here *****

4 Empirical Results

The regression results are reported in Table 3. The consistency of the GMM estimators requires valid instruments and also the absence of second-order serial correlation (Blundell & Bond, 2000). We use the lagged first differences of the dependent and explanatory variables from year 1 to 3 as instruments, and also employ the Hansen test for over-identifying restriction and overall validity of the instruments in the estimation process. The insignificant values of the Hansen J-statistics in models (2), (3) and (5) support the view that the instrumental variables are uncorrelated to residuals. The reported Hansen J-statistics are however significant in model (1) and (2), when only the control variables and OFDI are considered. This emphasises the importance of including the interaction terms in models (3)-(5). Moreover, the Arellano-Bond tests in all models indicate that the first-order AR(1), and not the

second-order AR(2), error terms are serially corrected. These further support the use of GMM for our estimation in models (3)-(5). We therefore focus our discussion on models (3)-(5).

***** Table 3 about here *****

In models (3-5), the lagged value of the dependent variable ($INN_{i,t-1}$) is highly significant as expected, as too is the RDI variable. The estimated elasticity of innovation with respect to R&D intensity is in the range of 0.3 to 0.5 in these models, suggesting that a 1% increase in R&D expenditure will lead *ceteris paribus* to an increase in the numbers of patents around 0.3-0.5%. This estimate is rather larger than that reported in other studies on innovation in China, where the estimated elasticities are typically 0.2 – 0.4 (Yang & Lin, 2012). GDP growth also has a significantly positive effect on innovation in models 3 and 4, though this results is not robust to the different model specifications. The other two control variables (FTECH and SOE) are insignificant throughout.

Three of four hypothesised variables and their direct effects upon innovation performance are highly significant throughout models (3)-(5). The most important in terms of economic significance is inward FDI (IFDI), where the estimated coefficient is in the range of 0.16 to 0.22: foreign-invested enterprises (FIEs) are presumably more disposed to innovate than domestic firms, and an increase of 1% in the annual flow of inward FDI is associated with an approximately 0.2% increase in regional innovation. Hypothesis 3a is thus supported. The impact of outward foreign direct investment (OFDI) is smaller, but still appreciable - the estimated coefficient is in the

range of 0.037 to 0.091 – and highly statistically significant, supporting hypothesis 1a. Perhaps the small coefficient reflects the fact that not all Chinese OFDI is market-seeking or strategic asset-seeking (and hence might lead to more innovations), whilst resource-seeking investments are unlikely to have the same beneficial effects upon innovation performance. Further work should attempt to differentiate between the effects of alternative OFDI motivations. The estimated coefficient of absorptive capacity (ABS) is in the range of 0.148 to 0.179 suggesting that a highly-educated workforce is a necessary prerequisite for a good innovation performance, supporting hypothesis H2a. However the direct impact of product market competition (COM) on innovation is statistically insignificant, presumably because the expected positive and negative effects have cancelled each other out or perhaps because possible sectoral effects are confounded within our aggregate regional measure of competition: hypothesis 4a is thus not supported.

In models (3) to (5), we also considered the three interaction terms one at a time. In model (3), the coefficient of the interaction term between OFDI and absorptive capacity (ABS) is positive (as expected) but statistically insignificant: furthermore its introduction has little effect upon the size and statistical significance of the direct effect coefficients. It thus appears that the effects on innovation performance of OFDI and ABS are additive, but that the hypothesised (H2b) moderating effect of regional absorptive capacity on the relationship between OFDI and domestic innovation performance is not confirmed. In model (4), the coefficient of the interaction term between OFDI and IFDI is positive (+0.108, $p < 0.01$) and

statistically significant – hypothesis H3b that inward FDI positively moderates the relationship between OFDI and regional innovation is supported. Clearly the positive impact of OFDI on domestic innovation performance is enhanced in regions where FIEs have greater presence, presumably because of a beneficial combination of demonstration and spillovers effects. And finally, model (5) reports the regression results when the interaction term between OFDI and product market competition (COM) is included. The coefficient of the interaction term is negative (-0.096, $p < 0.01$) and very statistically significant – hypothesis H4b is supported. Even though product market competition does not have a direct impact upon regional innovation performance, it appears to reduce the beneficial impact of OFDI presumably because firms operating in competitive markets are less willing to transfer advanced products and technologies back to China for fear of loss of intellectual property.

Conclusions

Many authors have investigated the beneficial impact of inward foreign direct investment on innovation performance in emerging economies, including several studies related to China (e.g. Fu, 2008; Cheung & Lin, 2004). But little is known about the potential effects on domestic innovation performance of outward foreign direct investment, particularly in the context of emerging economies. Yet OFDI from emerging economies has increased dramatically in recent years often, as in the Chinese case, supported strongly by home country governments.

The empirical analysis presented in this paper considers the effects of OFDI on innovation performance in 30 Chinese regions over an eight-year period (2003-

2010), and finds that OFDI has a very significant (both statistically and economically) impact on domestic innovation. Furthermore, we also identify three contingent factors - absorptive capacity, inward FDI, and the competition intensity of the local market - that moderate the impact of OFDI on innovation performance. We found a complementary relationship between inward and outward FDI on regional innovation. This result echoes recent calls for more attention to be given to the effects of inward FDI on outward FDI in China (Deng, 2012). Moreover, we also report a positive moderating role of regional absorptive capacity in facilitating local innovators to learn from cross-border investment. This finding supports the many extant studies that highlight the benefits of absorptive capacity in exploiting the embedded knowledge in inward FDI (e.g., Li (2011), Cohen and Levinthal (1990), Yang and Lin (2012)). Finally, we provided empirical evidence that domestic competitive intensity has a negative moderating influence on the reverse knowledge spillovers from OFDI on regional innovation performance. This confirms our view that the institutional context is important in assessing the OFDI-innovation relationship.

As regard to the practical implications, our findings suggest that OFDI may bring home country benefits over and above providing additional market opportunities overseas or securing access to key production inputs. Second, policy-makers should think carefully about the impacts on innovation when designing policies to promote OFDI, and procedures that encourage OFDI may in turn facilitate technological development at the local level. This recommendation, however, is tempered by the condition that certain levels of pre-existing R&D intensity in the home country are an

essential factor required to harness the benefits of OFDI. As the R&D intensity of China, and most emerging economies, is still far behind that of most developed countries (NBS, 2012), increased and steady levels of investment will be necessary to establish a healthy regional innovation system throughout China. Third, increasing regional openness and the attraction of more IFDI will not only bring in more advanced knowledge directly, it may also facilitate the exploitation of reverse knowledge flows associated with OFDI. Fourthly, it is also important for policy makers to consider the competitive environment that may impede reverse knowledge transfers associated with OFDI. This must be tempered by the realization that excessive preferential policies may also retard inward investment, which will have a counterbalancing negative impact on innovation.

This paper is not without limitations and future work might well explore the following issues. First, we used aggregate OFDI data, and did not identify the overseas destinations of the cross-border investments that we were studying. But OFDI flows to developed countries (such as the United States and the United Kingdom) may well be associated with higher levels of reverse knowledge transfers than OFDI to other emerging countries. Second, we cannot distinguish strategic asset seeking OFDI from other OFDI motivations (e.g. natural resource seeking). Future studies might wish to examine the roles of different types of OFDI in promoting innovation in host countries, and also to look at the impact of different entry modes (e.g. acquisition versus greenfield). Third, we used patents as an indicator of regional innovation. Future studies might employ questionnaire surveys that go beyond formal

R&D outputs to capture more of the essence of the channels through which OFDI affects innovation performance. Finally, we conclude with the observation that this study was motivated to see whether EMNEs might generate benefits for the innovation performance of their home economies in ways akin to that established for MNEs from advanced economies. The answer appears to be yes, though this assertion should be more rigorously tested using a multi-country sample of advanced and emerging economy MNEs.

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Table 1: Description of Variables

Variable name	Acronym	Operationalization
Innovation performance	INN_{it}	Natural log of granted patents per 10,000 residents of region i in year t
GDP growth rate	GDP_{it}	Natural log of GDP growth rate (percent) of region i in year t
Foreign technology purchase	$FTECH_{it}$	Natural log of foreign technology purchase value over the total value of technology transaction in region i in year t
State sector's share of output	SOE_{it}	Natural log of the share of capital investment of local SOEs' over the total of region i in year t
Research intensity	RDI_{it}	Natural log of R&D expenditure/GDP (percent) of region i in year t
Inward FDI	$IFDI_{it}$	Natural log of inward FDI flow (100 million US\$) in region i in year t
Competition	COM_{it}	Natural log of formula (5) of region i in year t
Absorptive capacity	ABS_{it}	Natural log of regional technical staff over the total employees of region i in year t
Outward FDI	$OFDI_{it}$	Natural log of outward FDI flow/GDP (percent) of region i in year t

Source: Data collected from various official statistical yearbooks and bulletins: the Statistical Bulletin of China's Outward Foreign Direct Investment, the China Statistical Yearbook on Science and Technology, the Database of China's Main S&T Index (DCMSTI), the Chinese Industry Economy Statistical Yearbook.

Table 2: Descriptive Statistics and Correlation Matrix

Variables	Mean	S.D.	INN	GDP	FTECH	SOE	RDI	IFDI	COM	ABS	OFDI
INN	2.724	4.320	1								
GDP	12.910	2.179	-0.196	1							
FTECH	1.306	4.038	-0.047	-0.023	1						
SOE	45.218	19.793	-0.391	-0.171	-0.047	1					
RDI	1.214	0.988	0.638	-0.089	-0.106	-0.132	1				
IFDI	655.870	998.246	0.729	-0.069	0.004	-0.587	0.37	1			
COM	1.718	2.010	-0.148	-0.074	0.054	0.276	-0.149	-0.181	1		
ABS	16.463	10.415	0.523	0.004	-0.053	0.060	0.641	0.26	-0.105	1	
OFDI	0.133	0.239	0.320	-0.102	-0.046	-0.173	0.192	0.211	-0.107	0.186	1

*p-value \leq 0.1, ** p-value \leq 0.05, *** p-value \leq 0.01.

Table 3: GMM Regression Results

	(1)	(2)	(3)	(4)	(5)
INN _{t-1}	0.600*** (0.086)	0.616*** (0.087)	0.624*** (0.085)	0.623*** (0.068)	0.641*** (0.091)
GDP	0.334*** (0.114)	0.136 (0.086)	0.154* (0.089)	0.152* (0.086)	0.057 (0.108)
FTECH	-0.016 (0.013)	-0.015 (0.012)	-0.013 (0.010)	-0.005 (0.011)	-0.010 (0.012)
SOE	-0.153 (0.127)	-0.013 (0.224)	-0.086 (0.221)	-0.075 (0.220)	0.010 (0.228)
RDI	0.505*** (0.126)	0.498*** (0.175)	0.527*** (0.163)	0.313* (0.160)	0.410** (0.176)
ABS		0.135*** (0.050)	0.148*** (0.049)	0.142*** (0.046)	0.179*** (0.049)
IFDI		0.208*** (0.052)	0.220*** (0.053)	0.192*** (0.042)	0.158*** (0.035)
COM		-0.009 (0.051)	-0.004 (0.048)	-0.019 (0.040)	0.004 (0.047)
OFDI		0.042*** (0.013)	0.037*** (0.014)	0.083*** (0.028)	0.091*** (0.024)
OFDI * ABS			0.026 (0.024)		
OFDI * IFDI				0.108*** (0.035)	
OFDI * COM					-0.096*** (0.021)
AR(1)	0.008	0.020	0.026	0.040	0.011
AR(2)	0.293	0.442	0.436	0.306	0.307
Hansen J-statistic	0.086	0.078	0.434	0.245	0.138
Observations	210	210	210	210	210
Number of regions	30	30	30	30	30

Robust standard errors in parentheses

*** p < 0.01, ** p < 0.05, * p < 0.1

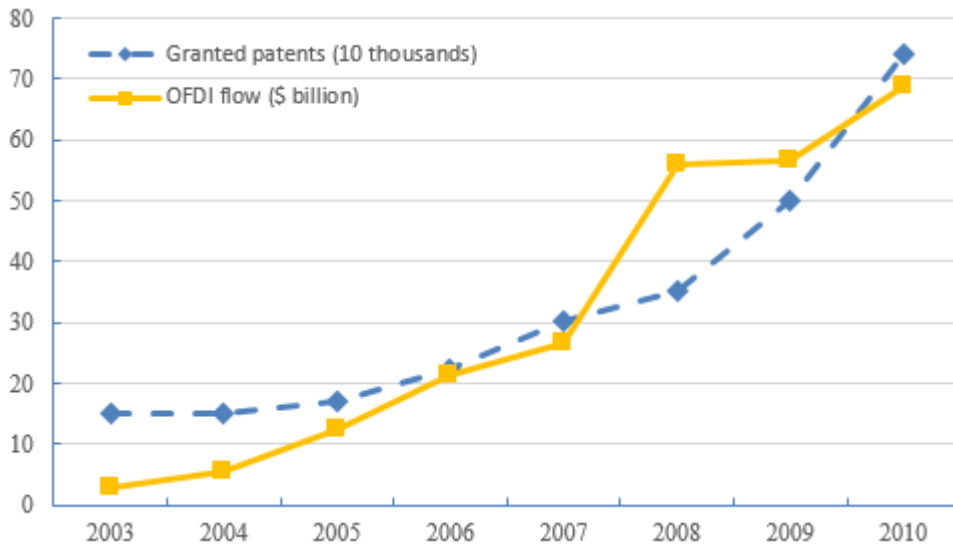


Figure 1: Granted Patents and OFDI flows in China, 2003-2010

(Source: the National Bureau of Statistics of China and Ministry of Commerce of China)

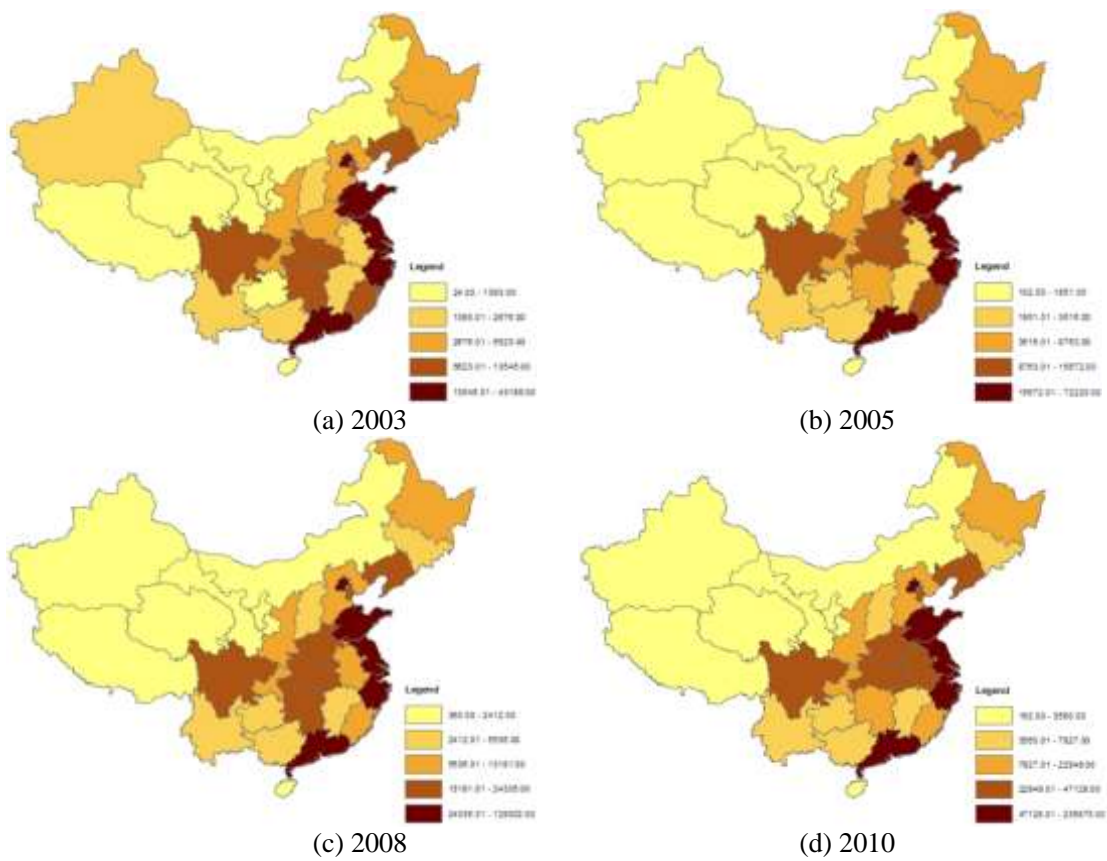


Figure 2: Geographic Distribution of Granted Patents in China, 2003-2010

(Source: website of SIPO, <http://www.sipo.gov.cn/tjxx/>)

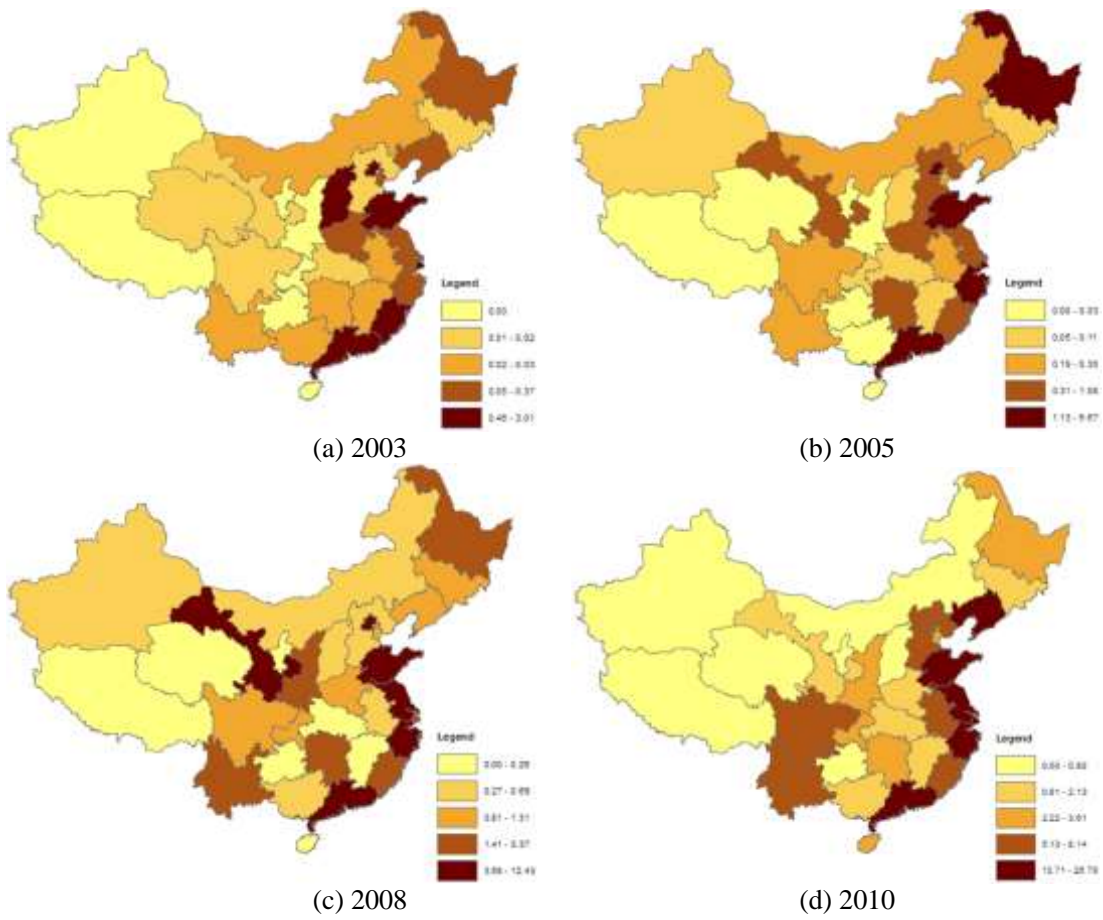


Figure 3: Regional Distribution of Chinese Outward FDI, 2003-2010
 (Source: Statistical Bulletin of China's Outward Foreign Direct Investment, MOC)