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The Role of Domestic Institutions and FDI on Innovation – Evidence from Chinese Firms

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Abstract

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This paper investigates the enabling factors of domestic institutions and foreign direct investment (FDI) in firm innovation in China. China has made significant institutional changes and has attracted substantial FDI, aiming to facilitate domestic innovation. Drawing on the institution-based view, we investigate how domestic institutions and FDI affect firm innovation. The results from a comparative case study of five Chinese firms and a large-sample econometric analysis based on Chinese firms reveal the positive impact of domestic institutions on innovation, but FDI is shown to have negligible effects. We argue that, given China's institutional setting, FDI may be a channel for technology transfer but this does not necessarily lead to innovation.

Keywords: Innovation; FDI; domestic institutions

1. Introduction

There is a consensus that innovation is the engine for economic growth at the macro-level and continuous innovation is the engine that drives highly successful firms at the micro-level (Schumpeter 1911; Pai 2016). However, despite a substantial amount of research on innovation and the recognition of recent developments in innovation in emerging economies, research on innovation of emerging economy firms, in general, and Chinese domestic firms, in particular, is still at a developmental stage (Lu et al. 2008; Li et al. 2010a).

Since China launched its open-door policy in 1978, the Chinese government has been striving to build formal institutions to facilitate domestic innovation. Priority has also been given to increase domestic technology base through acquiring foreign technologies, particularly through the channel of foreign direct investment (FDI) by multinational enterprises (MNEs).

As a result, we have witnessed significant institutional changes and substantial inflows of FDI (Wei and Wang, 2009). However, existing studies have not considered domestic institutions and FDI simultaneously in analyzing innovation. Indeed, institutional factors "have been relatively neglected in the study of knowledge management and innovation in the Asia-Pacific region" (Lu et al. 2008, 366)[2]. This is surprising, as the institution-based view (IBV) clearly argues that institutions matter for firm innovation. Institutions defined by North (1990) as the rules of the game in a society that provide stability, reduce uncertainty and alleviate information complexity in economic exchanges. Organizations undertaking innovation are deeply embedded in domestic institutions (Edquist 1997). The institutional environment, consisting of social, economic and political arrangements factors, is expected to shape firm's innovation strategy and activities.

In the strand of research on the impact of FDI on innovation in China, there are a number of recent studies including Cheung and Lin (2004); Liu and Buck (2007); Fu (2008); Girma et al. (2008); Liu and Zou (2008); Girma et al. (2009); Wang and Kafouros (2009); Li et al. (2010a); Li et al. (2010b); and Ito et al. (2012). However, they obtain mixed findings on the FDI-innovation relationship and none consider the role of domestic institutions.

Given the significant institutional changes in China and the widely acknowledged role played by FDI in China's economic development (Wei and Wang 2009), this paper aims to fill the research gap and answer the question: What are the roles of China's institutions and its integration in world production and R&D through FDI in influencing the innovation of Chinese domestic firms? We draw on the institution-based view (IBV) and argue that

[2] There is limited systematic research assessing the impact of domestic institutions on Chinese firm's innovation with the exception of Lin et al. (2010) who consider the impact of property rights protection, government services and government ownership of firms on innovation, but overlook the role of FDI.

institutions affect innovation because they incentivize firms to allocate resources to innovative activities and permit them to appropriate rents from innovation (Fabella 2006; Lu et al. 2008; Zhu et al. 2012). Given China's institution setting, which is still in the process of developing stronger institution for innovation, competition effects associated with FDI may outweigh positive spillover effects of FDI such as demonstration and labor mobility effects. Thus, FDI may not necessarily lead to more innovation in China.

To test the hypotheses, we combine illustrative case studies and a large sample econometric investigation. Five Chinese firms were interviewed during January and April 2016. However, given the limited sample size associated with company interviews, we also employ firm-level data from World Bank Enterprise Survey supplemented by industry data to examine to what degree qualitative findings can be generalized.

The rest of the paper is structured as follows. Following the review of existing literature, we develop hypotheses in section 2. Section 3 provides qualitative empirical findings based on firm interviews which offer us insights to how domestic institutions and FDI influence innovation. Discussion of quantitative data and research methodology is presented in section 4. Bearing in mind the mixed findings on FDI innovation spillovers in the existing literature, we use a range of measures representing different aspects of innovation in order to depict a relatively more comprehensive picture. Section 5 presents the results of quantitative analysis. The final section offers discussions and concludes.

2. Literature review and hypothesis development

2.1 Domestic institutions and innovation

According to Schumpeter (1911), the concept of innovation should be broadly defined to cover a wide range of matters that can drive forward economic development. Domestic institutions are significant to innovation as they can produce incentives or barriers for innovation. First of all, firms are deeply embedded in institutions and their innovative activities are constrained by institutions (Edquist 1997). Institutions define patterns of behavior; shape interaction among economic agents within or across industries, between university sector and industries, between suppliers and consumers and between foreign and domestic firms, and contribute to the development of innovation infrastructure including science and technology base and knowledge and talent pool (Dunning and Lundan 2008). Firms subscribe to institutions and develop their own strategies including innovation strategies accordingly. Romer (2010) shows an example of how changes in aviation rule book changes the institutional environment that affects innovation in China.

Second, knowledge development, the results of innovation, must be congruent with institutional requirements (Lu et al. 2008). Institutional requirements encourage certain behaviors but restrict others. Innovation is one of firm's responses to establish legitimacy and to adapt to the external institutional context by developing products, process and services that meet standards imposed by institutions, the process of isomorphism. As a way of seeking institutional approval, firms can use innovation to signal positive traits. For example, the reform of China's science and technology system in the 1980s and 1990s was dominated by the overriding concern of policymakers that emphasized the integration of research and production. As a result, firm innovation and creative activities focus more on the exploitation rather than the exploration of knowledge (Baark 2007).

Third, the efficiency and effectiveness of innovations are affected by institutions (Lu et al.

2008). When firms face significant institutional constraints, e.g. unsupportive/ inefficient governmental services, poor execution of laws and regulations and the shortage of technicians and engineers (Zhu et al. 2012), the costs associated with innovation could rise or the efficiency of innovation could be reduced, e.g. extra resources might have to be allocated to protect the innovation process and to prevent information leakage. Conversely, well-established and efficient institutions make it easy to access information and provide adequate and high-quality resources and services for innovation by securing the implementation of laws and regulations, protecting IPR, stimulating competition, improving communication and building networks between economic agents (Dunning and Lundan 2008). Institutions, therefore, alter the structure of incentives for innovation and direct businesses toward more economically productive activities. In summary, these theoretical discussions suggest a significant role played by institutions in innovation.

Institutions have many dimensions. In the following discussion, we examine institutions as reflected by government assistance, property rights protection and external networks. Government assistance refers to the extent to which a firm receives supports from governments in the form of favorable policies, incentives and programs (Li and Atuahene-Gima 2001). Dunning and Lundan (2008) uphold government assistance a country's institutional framework. Government assistance can influence firm innovation through imposing coercive pressures and institutional supports. Nye (2011) suggests that, at the core of new institutional economics, is the choice between promoting production and voluntary exchange versus predation. While the state or the government enforces the rules of cooperation and contracting, the government is also powerful enough to manipulate these rules for its own benefit. This is particularly relevant to China. Since opening-up in 1978, the Chinese government has endeavored to advance the country's science and technology

through setting rules, monitoring and sanctioning activities, and investing heavily in R&D activities. For example, in the most recent five-year plan, China's 12th five-year plan, government set specific R&D spending target as 2 percent of GDP, just below the current level of the United States, which stands at 2.8 percent. By complying with institutional constraints, firms are able to gain government assistance. Government assistance can also provide firms with access to scarce resources, e.g. funding and technical assistances, at low-cost, which can also give firms a competitive advantage over their rivals. Zhu et al. (2012) interviewed 82 top managers and owners in 41 Chinese high-tech SMEs and find that government support is one of the most important institution-based factors in influencing firm innovation. Fan (2006), using case study approach to examine four Chinese firms – Huawei, ZTE, DTT and GDT – also find the significance of government assistance in these telecom-equipment firm's innovation. Lin et al. (2010), in their econometric study of firm innovation, also reveal the statistical significance of government assistance in being conducive to innovation.

Hypothesis 1: Government assistance positively affects Chinese firms' innovation.

Property rights protection is recognized as a significant part of institutions (Dunning and Lundan 2008; Lin et al. 2010). The influential literature on law, economics and finance has established the importance of legal institutions in business activities (La Porta et al. 2008). It is widely accepted that strong protection of property rights gives firms an incentive to innovate. Without it, rewards from innovation would be compromised; as a result, firms would be reluctant to innovate. North (1990) considers the lack of property rights protection as the contributor towards developing country's "historical stagnation and contemporary underdevelopment". Empirical evidence on innovation and property rights protection in

China supports the positive relationship between the two variables. Lin et al. (2010) show that property rights protection matters strongly to firm's innovative activities. This finding is echoed by interviewees in Zhu et al. (2012) who clearly identify the weakness of property rights protection to be one of the institutional barriers to innovation in China.

Hypothesis 2: Property rights protection positively affects firm innovation.

Firms' external resources and capabilities are equally important for innovation (Dunning and Lundan 2008). First, the innovative process is often based on interactions, feedbacks and collaborative efforts between different economic agents such as firms, R&D institutions, universities and government departments (Lundvall 2007). A large share of innovative activities is produced by R&D institutions and universities. Actively engaging in networks with these economic agents benefits firms from external information knowledge, which is important to the success of innovative activities. Second, the connections between firms and these economic agents can significantly affect the ways through which technologies are diffused and influence the rates at which existing products and processes integrating with new ideas, hence, generate innovative outputs. The pace and scope of technological change in today's competitive environment therefore requires firms to count on external networks for the benefits of external knowledge, complementary assets and risk sharing.

Hypothesis 3: External networks of firms positively affect domestic firm's innovation.

2.2 FDI and innovation

An extensive literature on knowledge spillovers of FDI has emerged in the last decades (Meyer and Sinani 2009), arguing that FDI brings into host countries advanced technologies

and effective management techniques thus should have a positive impact on domestic firm performance. However, most studies focus on performance as reflected by productivity rather than on innovation.

FDI can affect innovation of domestic firms through a number of channels including demonstration effects, labor mobility, access to finance, and competition effects (e.g. Cheung and Lin 2004; Lin and Lin 2010; Chen and Fang 2016) and the potential effects can be both positive and negative. There is a high degree of persistence in the innovative behavior of MNEs (Hosseini and Narayanan 2014). MNEs, through FDI, transfer knowledge, the results of innovation, to host countries and contribute to the technological upgrading of host countries (Findlay 1978; Wang et al. 2014; Chen and Fang 2016). As knowledge is non-rival and partially excludable, it is possible for indigenous firms to learn some of the knowledge through learning-by-doing, learning-by-watching and reverse engineering and to develop new products and processes (Findlay 1978; Cheung and Lin 2004). In addition, skilled employees move from MNEs to local firms or set up their own companies and bring with them the knowledge embedded in MNEs which may contribute to indigenous firms' innovative activities (Cheung and Lin 2004). Further, MNEs inject much-needed funds to local economy for innovation as innovation is costly and risky (Girma et al. 2008). Moreover, MNEs' affiliates will render the market they enter more competitive, forcing indigenous firms to engage in innovation in order to stay in competition (Girma et al. 2008). These arguments point to the positive impact of FDI.

Conversely, FDI can discourage indigenous firms from innovation. MNEs may "crowd out" indigenous firms in both resource and product markets (Girma et al. 2008). They compete with indigenous firms for capital, land and skilled labors, which forces up the production and

operating costs of indigenous firms and reduces their profitability, and resources available for their own innovation or taking advantage of innovation spillovers from FDI (Liu and Buck 2007). Because of their strong reputation, MNEs may have an advantage over indigenous firms in securing bank loans. MNEs often provide more attractive offers to local talent, which pushes up wages (Girma et al. 2008). Indigenous firms may also lose out in the provision of final goods and services because of MNEs' strength in brand names and quality of the products (Dunning and Lundan 2008). As a result, the competitive pressure associated with FDI may be harmful to local innovation.

In the Chinese context, we need to consider the role of FDI against the country's institutional background. Domestic institutions are seen as an important location advantage of the host countries which attract FDI inflows. In an institutional environment that ensures transparent regulatory regimes and property rights protection (Meyer et al. 2009), resources are more likely to be directed to the "right" economic agents, which accelerates linkages between foreign and domestic firms. MNEs are attracted to such location. They may transfer more technologies and knowledge to local subsidiaries and undertake more innovative activities locally, thus increases the scope for potential spillover effects from FDI. However, in China, as in other emerging economies where "institutional void" exists, knowledge transferred from the headquarters to local subsidiaries may not be at the most advanced level and local innovation by subsidiaries may be limited as they are costly and risky activities for MNEs (Zhu et al. 2012). As a result, the knowledge pool that has the potential for FDI spillover effects can be limited. Domestic firms might 'steal' knowledge and technologies from foreign firms, given "institutional void", e.g. weak property rights protection, but there is limited knowledge pool to draw resources for their innovation through demonstration, labor mobility and access to finance effects. At the same time, facing strong competition from MNEs,

domestic firms may have to divert resources for innovation to other productive activities to defend their market position, resulting in negative effects of FDI on innovation.

Given the above debates, the net impact of FDI spillovers on innovation is not clear-cut. It can be positive, negative or statistically insignificant. Among a number of papers on FDI innovation spillovers in China, positive spillovers on innovation proxied by patents are found in Cheung and Lin (2004); Fu (2008); Hu and Jefferson (2009); Sun and Du (2010) and Ito et al. (2012). Zhang and Rogers (2009) identify negative FDI innovation spillovers. Sun (2000) shows that FDI does not have significant influence on patents for typical provinces in China. When innovation is proxied by new product sales, Liu and Buck (2007); Liu and Zou (2008); Wang and Kafouros (2009); Li et al. (2010a); and Li et al. (2013); find positive FDI spillovers, Girma et al. (2008) discover negative ones and Sun and Du (2010) fail to identify any spillover effects. However, none of these studies control for domestic institutions. We argue that given China's institutional setting, FDI is unlikely to stimulate innovation because competition effects outweigh positive FDI spillover effects.

Hypothesis 4: FDI does not positively affect firm innovation in China.

3. Case studies

To empirically investigate the role of domestic institutions and FDI in the innovation of Chinese manufacturing firms, five companies were selected and senior managers were interviewed during January and April 2016. Table 1 presents a summary of the firm and interviewee profile. Case study methodology is provided in the Appendix. Three common findings about a firm's R&D activities emerge from interview and secondary data. First, all

companies, regardless of their size and industry, made significant investments in R&D, ranging from 4-6 percent of annual total revenue.

Second, all R&D activities were related to new products and processes, though there were some variations. For example, Midea's main forms of R&D outcome were new and imitative products and process innovation was mainly reflected in cost control. Imitative products were considered an important part of firm's R&D activities as the products, though not new to advanced countries, were new to China. In contrast, Haier's product innovation was related to more advanced products that were truly new even for international market. Haier's process innovation was also not limited to cost control but quality control. Third, large companies such as Midea, Haier and Bosideng also invested significantly in staff training to improve their technical and managerial skills.

<Table 1 Here>

In terms of the impact of domestic institutions, as reflected by government assistance, intellectual property protection and external networks, all interviewees confirmed that they received government assistance, ranging from financial support from regional and national governments, tax reduction and exemption on new products, identification of foreign partners for R&D collaboration to simplified bureaucratic procedures and processes. All interviewees agreed that the efficiency of law system and the quality of law services had been improved over the past decades and these were beneficial for firm innovation. Also confirmed was the significant positive role played by external networks in supporting innovation. In summary, domestic institutions impact firm innovation.

Mixed findings are found about the role of FDI in innovation. With the exception of Midea whose interviewee suggested strong competition effects from foreign MNEs, all other firms did not feel much of the effects of foreign MNEs on their innovation. Midea's R&D manager explained because of the strong competitive pressures from foreign MNEs, the firm had focused less on original innovation to produce new products due to the risks and costs associated with original innovation. To verify whether the findings from five cases are not specific to the firms concerned, we now turn to the econometric study.

4. Data, variables and methodology

The main data source used for econometric analysis is *World Bank Enterprise Survey* (WBES) on the Chinese firms in 2003.[3,4] The survey was carried out in collaboration with the Chinese National Bureau of Statistics and was part of a World Bank's larger project aimed to studying the investment climate or business environment at the firm level in a range of countries. This dataset covers 18 cities and 6 major manufacturing industries. The cities are Benxi, Changchun, Changsha, Chongqing, Dalian, Guiyang, Harbin, Hangzhou, Jiangmen, Kunming, Lanzhou, Nanchang, Nanning, Shenzhen, Wenzhou, Wuhan, Xian, and Zhengzhou. The industries are garments, electronics, food, vehicles and vehicle parts, metals and machinery, and chemicals and pharmaceuticals. This dataset has the characteristics of representativeness and reliability. First stratified sampling techniques are used to ensure a good representation of the population of firms in chosen locations and industries. In addition, private contractors were employed to collect data via face-to-face interviews with the

[3] There are also 2002, 2005 and 2012 surveys on Chinese enterprises. However, different questionnaires were used in those surveys and they do not contain many of the variables under investigation in this paper, e.g. government assistance, R&D services, and property right protection. Therefore, they are not used.
[4] This dataset has been used in previous research including Brambilla et al. (2009); Cull and Xu (2005); and Lin et al. (2010).

accountants/personnel managers of firms and the senior managers of main production facilities to ensure data reliability.

Detailed questions were asked regarding ownership structure, input, output, production, exports, foreign involvement, institutions and innovation activities. Firms were interviewed once in 2003. For some questions, e.g. input, output, production, exports and innovation activities, the answers cover 3-year period of 2000-02.

Data on FDI variables were obtained from various issues of China Statistics Yearbook on Science and Technology 1999-2003. All nominal variables were deflated using produce price indices (base year = 1998) from China Statistics Yearbook 1999-2003. The dataset includes 2,400 firms, of which 1,609 are manufacturing firms. As this research focuses on indigenous firms' innovation, 158 foreign firms are excluded[5]. We checked the dataset for missing values and outliers. The final sample includes between 532 and 1,119 indigenous Chinese firms and 1,621 and 3,518 firm-year observations.

To achieve a comprehensive understanding of innovation, we use a range of measures related to new products, patents and the types of innovation that firms engage to mitigate the deficiencies inherent in any particular measure. Typically existing innovation studies use one of the three major aspects of innovation: input measures (e.g. R&D expenditure), intermediate output measures (e.g. patents) or direct output measures (e.g. new product sales (NPS)) (Acs et al. 2002). As an input measure, R&D expenditure cannot measure the 'efficiency' of knowledge development. An increase in R&D spending does not imply an

[5] Firms were asked whether they were subsidiaries/divisions of multinational firms or international joint ventures.

increase in innovation output. Patent is an output indicator of innovation and is found to provide a fairly reliable measure in the context of the United States (Acs et al. 2002). However, it does not capture market acceptance of innovation outcomes and does not include those innovations that are not patented (Liu and Buck 2007). NPS indicates market acceptance of new products and may also reflect innovations that are not patented (Liu and Buck, 2007). Furthermore, we differentiate product and process innovation. Product innovation reflects a firm's status in new products or new business line development while process innovation reflects a firm's status in new process, new management techniques and new quality controls development (Lin et al. 2010).

We employ six measures in total. Two are associated with new products: the propensity of developing new products (PNP) (i.e. whether a firm introduced new products or services in existing business lines with one indicating yes and zero no) and the logarithm transformation of the volume of new product sales (NPS). Two are associated with patents: the propensity of patenting (PP) (i.e. whether a firm acquired patents with one indicating yes and zero no) and the number of patents granted to a firm (PG). With regard to the types of innovation, firms were asked whether they introduced new products or services in existing business line, entered new business line, undertook new process improvement, developed new management techniques and carried out new quality controls in production with one indicating yes and zero no. Each of the above five questions requires the answer of 'yes' or 'no' with '1' indicating 'yes' and '0' 'no'. The answers to the first two questions are used to identify whether firms engaged in product innovation (NPdI), while those to the last three questions to ascertain whether process innovation (NPcI). We use the sum of the answers to the questions to produce two ordered variables with NPdI ranging between 0 and 2 and NPcI between 0 and 3. The higher the value, the more types of innovation that a firm engages.

The primary independent variables of interest are FDI and domestic institutions. Following Liu and Buck (2007), FDI spillovers variable (FDI) is measured by the share of foreign firm's R&D expenditure in the industry. A one-year lagged FDI variable is used to mitigate endogeneity effect. Existing studies on institutions tend to use country-level indicators (e.g. Bénassy-Quéré et al. 2007; Meyer et al. 2009). However, such measures may not be the best option when investigating firm-level activities. Firms may face the same institutions but experience different degree of impact in practice and firms may also perceive them differently. Firm-perceived measures can be advantageous as it is the perceptions of decision makers towards their business environment which may affect the decision-making process (Santangelo and Meyer 2011). Perception-based indicators are useful because they can be adopted to capture different aspects of an institutional environment which are difficult to measure objectively. Perception-based indicators are informative because they suggest how firms experience institutional impact (Kaplan and Pathania 2010)[6].

There is no agreed measure on domestic institution in the existing literature. China has tried to build institutions to facilitate indigenous innovation and to develop a comprehensive legal system including property rights protection, to provide assistance to launch R&D programs, to develop universities and research institutes and to promote interactions between actors of innovation. The dataset allows us to reflect three main components of institutions, namely, government assistance, property rights protection and external networks.

To measure government assistance, we employ the following questions "During the year of

[6] There are several existing studies that use firm-perceived indicators. For example, Puck et al. (2008) use firm-perceived indicators of the business environment in China to study the entry-mode conversion of foreign-invested firms.

2002 did any government agency or official assist you in identifying foreign investors, locating foreign technology to license, identifying potential foreign clients, identifying potential foreign suppliers, obtaining bank financing and identifying potential domestic clients". Answers to these questions are combined to reflect the level of government assistance. Following Lin et al. (2010), we capture the property rights protection using the question, "What is the likelihood that the legal system will uphold my contract and property rights in business disputes?". To measure external networks, we employ the questions about whether firms had a contractual or long-standing relationship with local universities, research institutions or other firms between 2000 and 2002, with 1 indicating "Yes" and 0 "No". The answers to all three questions are aggregated with higher value indicating wider external networks of a firm.

Following the extant literature on innovation, we include a number of control variables: R&D expenditure, R&D personnel, export and competition (e.g. Fu 2008; Liu and Buck 2007; Lundvall 2007). R&D expenditure and R&D personnel play a dual role in the innovation process: developing innovation and enhancing learning capacity of firms which further enhances innovation (Liu and Zou, 2008). R&D expenditure and R&D personnel are major inputs into innovation and capture a firm's internal resources and capabilities used for innovation. The former reflects a firm's resource commitment, while the latter embodies human capital, an essential ingredient for innovation. R&D expenditure is measured by the ratio of R&D expenditure to total sales. R&D personnel are the number of people engaged in R&D which is also linked to a firm's scale of R&D engagement.

Export is recognized as a significant factor in improving innovation performance of firms (Cheung and Lin 2004; Girma et al. 2008; Girma et al. 2009; Liu and Buck 2007; Liu and

Zou 2008; Sun and Du,2010; Wang and Kafouros 2009). First, exporting exposes firms to international markets that are more competitive than the home country market. This pushes firms to be more innovative. Second, the international exposure provides firms opportunities to access new information and knowledge, and may secure technological assistance and supports from exporting partners, which can directly affect innovation. Export is measured by the logarithm transformation of a firm's exports.

Finally, competition is another frequently mentioned variable that could significantly influence innovation. Firms increase their innovative efforts to protect market share and remain competitive (Brambilla et al. 2009). However, competition may also reduce the incentives for innovation as a firm cannot quickly extract rents from innovation. Instead it may opt for imitation or licensing to acquire external R&D. The level of competition is captured using the number of major competitors within the main business lines in the home country market, a question asked of firms in the questionnaire.

Before proceeding to the discussion of estimation methods, it is important to recognize common method bias variance (CMV) in using survey data because questions are normally responded by only one respondent in a firm. Because our variables employ information from more than one data source and objective measures are used, CMV is unlikely to be a problem.

Existing studies on innovation often investigate innovating firms only (Fu 2008; Liu and Zou 2008; Lin and Lin 2010). This excludes a crucial part of the innovation decision: whether the firm decides to innovate at all. As shown by Du et al. (2007), a two-stage model (firm decides whether to innovate, then which type of innovation to undertake) outperforms a one stage, simultaneous model. We therefore model innovation as a two-stage decisional process. The

first stage is to model whether or not firms innovate using PNP and PP and the estimations are carried out using Logit models. For the second stage decision, NPS is estimated using Tobit model as data for NPS are left-censored at zero and the distribution of the sample is a mixture of discrete and continuous distributions. Given the non-negative and discrete nature, patent follows Poisson distribution. However, because a large number of data take zero value, to allow for 'over dispersion' into the data, the negative binomial model is used for the model with PG as dependent variable. This produces improved efficiency in estimations. Finally, because NPdI and NPcI are ordered variables, the ordered logistic models are employed.

Given the nature of datasets with long cross-sections but short time-periods, we use robust errors so as to take into account the heteroscedasticity issue. In all models, a number of dummies are also incorporated. City dummies are used to control for location-specific effects. Variations in innovation may be associated with the industry to which an indigenous firm belongs. High-tech industries tend to be more innovative than low-tech industries. Dummies are introduced based on OECD's Technology Intensity Definition in 2011 to control for industry-specific effects. Firm's main business lines are used for the industry classification. For all regressions, multicollinearity is checked using Spearman correlation coefficients and variance inflation factors (VIF).

4. Empirical results

Table 2 presents summary statistics and correlation coefficients. As shown in Table 2, no pair of the independent and control variables is highly correlated. VIF scores are all lower than the usually accepted threshold level of 10. Table 3 presents the estimation results. In terms of domestic institutional factors, government assistance has a positive and significant impact on

all innovation measures except PNP. Property rights protection generates a significant and positive effect on NPdI and NPcI only. External networks show consistently significant and positive effect on all innovation measures. These results broadly support hypotheses 1-3, indicating that institutions in the form of government assistance, property rights protection and external networks positively influence the innovation of Chinese indigenous firms.

<Tables 2 & 3 Here>

Turning to the impact of FDI on innovation, it is clear that FDI has significant and negative effects on patent, in terms of both the propensity of patenting (PP) and the number of patents granted (PG). But its effects are statistically insignificant on the propensity of developing new products (PNP), new product sales (NPS) and two different types of innovation (NPdI and NPcI). These results indicate that innovation by Chinese indigenous firms is not affected or is negatively affected by FDI.

Table 3 also clearly shows the importance of control variables. R&D expenditure significantly and positively influences NPS and NPdI. R&D personnel is shown to be significant and positive in all models. Export appears to be significant and positive in all except the one for PNP. Finally, competition generates consistently negative effects on almost all aspects of innovation except PNP.

4.1 Robustness tests

As robustness tests, we also performed estimations using the composite institution variable which is created using factor analysis based on three institution variables. The results are fairly consistent with those in table 3. The composite variable shows to consistently

positively and significantly affect innovation in all models. FDI remains to be negative and statistically significant in PP and PG and statistically insignificant in PNP, NPS and NPdI. But the negative coefficient of FDI in NPcI model becomes statistically significant at the 10 percent level.

5. Discussions and conclusion

The existing literature on innovation has not considered domestic institution and FDI in an integrated framework. Following an institution-based view, we argue that institutions should be put in the forefront rather than being treated as "background" when investigating innovation and the investigation of the role of FDI should be placed again host country's institutional context. This is especially important when examining innovation in China where the Chinese government has made substantial efforts in institution building for innovation since opening-up. For example, the Science and Technology Development Plan (2006-2020), starting from the year 2006, aimed to upgrade production toward higher value-added goods and transform China to be an innovative country by 2020 and an innovation leader by 2050. Meanwhile, the Chinese government has also been making efforts to improve formal institutional arrangements for attracting FDI. Over time FDI to China has changed, moving away from low-tech manufacturing to more technology-intensive activities. Nevertheless there remain restrictions on the operations of MNEs in China (Sjoholm and Lundin 2013). Some of these restrictive policies include barriers for MNEs to acquire Chinese companies and barring entry of MNEs in certain industries on grounds of national security concerns as well as "economic security" criteria.

Our empirical findings from both case studies and econometric analysis suggest that the

institutional factors have a significant impact on innovation. All interviewees recognized government assistance as a critical factor for innovation. The Chinese government exerts greater influence on firms at various levels than their counterparts in advanced economies. The econometric findings suggest government assistance facilitates firms to generate more patents, to consider the introduction of new products, and to enjoy more new product sales. Government assistance also helps generate more product and process innovations and integrate innovation with production. The Chinese government should, therefore, provide firms with adequate and high-quality support and services which would, in turn, lead to more innovation.

Government assistance can take various forms including designing and implementing supportive policies, allocating resources and building links between economic agents (Lu et al. 2008). Rothwell and Zegveld (1982) suggest that tax concessions, entrepreneurial education, the networks of industrial research organizations, and technical and information services are important to innovation. Zhu et al. (2012) argue that the quality of government support can significantly affect innovation. Our case study evidence pointed out the following forms of government assistance as particularly important to firm innovation: tax concessions upon new and innovative products, subsidies, training managers in key positions, providing market information and building up links between economic players. The government assistance should be publicly available and accessible for firms undertaking innovation and it serves as an incentive and supportive mechanism for innovators. However, three out of five interviewees indicated that both the level of sufficiency and quality of government assistance provided needed improvement. Nevertheless, all interviewees agreed that Chinese governments of various levels had been making efforts to promote the relationship and interactions between firms and governments; the governments ‘co-evolutes’ with firms

aiming to provide better services. All interviewees also pointed out that the previous complicated administrative procedures had been somewhat simplified over time, which has allowed firms to focus more on R&D and production.

The interview evidence reveals that big firms – Haier, Midea and Bosideng – considered the protection of property right as one of the most important determinants of their innovation activities and the econometric analysis shows that property rights protection promotes new product and new process innovations. This finding lends support to the existing theoretical arguments. For example, North (1990) considers property rights to be a key to channeling resources towards productive investments. Dunning and Lundan (2008) regard IPR enforcement as the most critical part of the institutional structure of host countries in promoting knowledge transfers and attracting innovative activities of MNEs. Since opening-up, China has made improvements in recognizing property rights and implementing laws and regulations governing property rights protection. Although there are still gaps with the advanced economies, China has been actively involved in many international conventions regarding property rights protection such as the Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS). These international conventions require China to comply with international requirement, which leads China to modify its legal system and regulatory framework. Interview evidence suggests that firms across industries have witnessed significant improvement of property right protection in China. For example, the interviewees from Haier and Bosideng said that as the leading enterprises in the Chinese home appliance industry and textile industry respectively, both firms encountered violations of intellectual property rights (IPRs) over time. Previously when IPR protection was weak, law enforcement and the efficiency of legal system were poor, firms faced high costs and risks of doing R&D for them, which reduced their incentives to innovate. However, the

strengthening of legal protection of property rights now encourages both Haier and Bosideng to conduct more innovation. Additionally, the two small private enterprises that we interviewed, in contrast, gave evidence that it was more difficult for them to imitate. Despite the improvement, China still has a long way to go on the front of property rights protection. A large number of Chinese firms still rely heavily on imitating new products and patents rather than making original innovations (Brambilla et al. 2009). Illegal imitation and the violation of property rights are prevalent in China, which bring risks to innovators. To change the scene, the Chinese government should strengthen law enforcement which in turn would promote innovation. In the meantime, Chinese firms should enhance their awareness of laws and use laws to protect their interests and returns from R&D. Firms should apply for patents and trademarks and work closely with relevant governmental departments such as the patent office to detect illegal imitation and violations of property rights to protect their interests.

Econometric results suggest that external networks positively affect all aspects of the innovation of indigenous Chinese firms. Interview evidence confirms that external networks serve as important channels for direct help and supports and indirect spillover effects from external sources. This is especially true and important for small- and medium-sized enterprises such as the two private enterprises Lida and Richen. The interviewees from both firms consider that external networks with other firms, suppliers, partners, banks, governments, universities and R&D institutions are critical factors for their performance. A firm is embedded in external networks, as a result, has the potential to access R&D resources from external networks. Actively interacting with other firms, business partners, R&D institutions and universities is important in improving innovation. A strong external network promotes interactions between socio-economic agents and facilitates information and knowledge sharing. With a robust external network, a firm can enjoy benefits derived from

interactions with other economic agents and such interactions influence the development of R&D. Therefore, the Chinese government should help firms build and extend their external networks and facilitate interactions between firms and other economic agents with the purpose of sharing information, knowledge and experience of production and R&D.

FDI clearly has a negative effect on the patents of indigenous manufacturing firms. This finding is in line with several empirical studies (Chen 2007; Sun and Du 2010; Zhang and Rogers 2009). This demonstrates that the fierce competition between MNEs and indigenous Chinese firms. Indigenous Chinese firms may concentrate more on production rather than original innovation. Sinani and Meyer (2004) argue that indigenous firms may lose employees with talent and skills to foreign firms as MNEs normally provide higher salaries and better rewards to lure and retain these employees. This consequently reduces indigenous firms' capabilities in innovation. The increased competition brought by MNEs may reduce the market share of indigenous firms and affect their profitability, which in turn may restrict their capabilities of investing into innovative activities. Du et al. (2008) indicate that firms that cannot meet the new technological challenges may be crowded to the periphery of the industry. As a result, they may be inclined to concentrate on more labor-, rather than technology-intensive products. Indigenous firms may also heavily depend on foreign technologies brought by MNEs and reduce their own innovation activities. All of the above scenarios may indicate the negative and/or statistically insignificant FDI innovation spillover effects. Results from interviews indicate that innovations of the private firms are not significantly affected by MNEs. Lida and Richen are small in size and focus only on niche markets. They were not in direct competition with MNEs while for Haier, Midea and Bosideng, they face competition from foreign firms in their target markets, in the meantime, they have connections with MNEs in the forms of partnership or supply chain relationship.

When being asked ‘do you view foreign presence in your main business lines as a positive impact or a negative impact?’, the interviewees from Midea and Bosideng suggested that the negative impact was more significant even though FDI brought about positive spillover effects sometimes. They suggested that foreign counterparts were better positioned in both resource and product markets and they had stronger bargaining power when negotiating with governments, suppliers and customers. While, for Haier, the interviewee suggested that Haier was one of the industry leaders and it had strong firm-specific advantages such as R&D capability, international experience, management skills, brand image and recognition and consumer base and loyalty, all of which helped Haier in effectively competing with foreign counterparts in the Chinese home appliance market.

Our empirical findings may be applicable to other Asian economies where governments have played active role in business environment, property rights protection has been improved and extensive external networks have been built up that encourages interactions, feedbacks and collaborative efforts between different economic agents such as firms, R&D institutions, universities and government departments. These institutional factors can facilitate indigenous innovation.

Future research may follow three directions. First, institutions could affect firm innovation activities or the proclivity of firms to innovate indirectly through various channels. The current study only considers the direct effects of institutions. The possible moderating role of institutions is worth considering. Second, though this study has found that FDI has not exerted positive direct effects on innovation, FDI may affect innovation indirectly through, for example, affecting market structure and/or the degree of competition. Third, though it is found that government assistance positively affect innovation. Government assistance is not

cost free, it is therefore important to conduct cost-benefit analysis on government assistance.

Appendix: Case study methodology

We conducted case studies of five companies to complement econometric analysis. We used personal contacts and external networks to try to reach potential interviewees. The interviewees were carefully selected based on their positions and the likelihood of providing needed information. After substantial efforts, we managed to access five interviewees from five different companies. All interviewees have extensive knowledge of their own company including R&D activities and the industry in which the company operates. This ties in strongly with people's "knowledge, views, understandings, interpretations, experiences and interactions" (Mason 2002, 63). The semi-structured interviews with open-ended, exploratory questions were conducted either through face to face interview or by telephone.

Chinese, interviewees' native language, was used in the interviews. This gives interviewees an opportunity to freely offer their opinions and understanding of the topic. Under the guarantee of anonymity, interviews were transcribed as soon as possible to minimize information loss. In line with established qualitative research protocol, interviews were supplemented with observations and secondary data sources such as public documents, media reports, company archives and company websites to check for validity (Yin 2014). We began data analysis by synthesizing the interview data and the secondary data. After developing a comprehensive understanding of each case around our research questions through reading and coding all interviews and documents, we conduct within-case analysis, then cross-case analysis.

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Table 1. Firm and interviewee profile

Company	Ownership	Industry	Interviewee	Number of employees
Midea	Share-holding company	Home appliance	R&D manager	130,000
Haier	Share-holding company	Home appliance, electronics, pharmaceutical, real estate	Production manager	60,000
Bosideng	Share-holding company	Garment	R&D manager	20,000
Lida Steel Structure Co. Ltd	Private company	Steel structure and temporary building projects	General manager	300
Richen Food Co. Ltd	Private company	Food processing	Production manager	240

Source: Company reports

Table 2. Sample statistics and correlation analysis

Variable		Mean	s.d.	7.	8.	9.	10.	11.	12.	13.
1.	PNP	0.831	0.375							
2.	PP	0.138	0.345							
3.	NPS	7.246	3.911							
4.	PG	0.391	2.063							
5.	NPdI	0.734	0.828							
6.	NPcI	1.639	1.229							
7.	FDI	0.245	0.122							
8.	Government Assistance	0.793	1.286	0.084						
9.	Property Rights Protection	64.749	37.900	0.020	0.095					
10.	External Network	0.417	0.754	0.005	0.236	0.049				
11.	R&D Expenditure	2.531	26.515	0.084	0.240	0.078	0.326			
12.	R&D Personnel	27.919	148.657	0.066	0.292	0.082	0.347	0.626		
13.	Export	1.677	3.625	0.150	0.090	0.051	0.065	0.109	0.158	
14.	Competition	3.753	1.308	-0.035	-0.118	0.010	-0.216	-0.273	-0.311	-0.037

Notes:
PNP = whether a firm introduced new products or services in existing business lines; PP = whether a firm acquired patents; NPS = new product sales; PG = the number of patents granted; NPdI = whether a firm engaged in product innovation; NPcI = whether a firm undertook process innovation

Table 3. Domestic institutions, FDI and innovation

	Logit	Logit	Tobit	Negative Binomial	Ordered Logistic	Ordered Logistic
	PNP	PP	NPS	PG	NPdI	NPcI
FDI	0.972	-4.362***	2.429	-7.95***	-0.44	-0.871
	(1.141)	(0.986)	(1.991)	(1.669)	(0.629)	(0.551)
Government Assistance	0.023	0.151***	0.248***	0.127**	0.18***	0.239***
	(0.052)	(0.036)	(0.072)	(0.057)	(0.028)	(0.031)
Property Rights Protection	-0.002	0.001	-0.000	0.003	0.005***	0.002**
	(0.002)	(0.002)	(0.003)	(0.002)	(0.001)	(0.001)
External Network	0.488***	0.484***	0.674***	0.362***	0.634***	0.690***
	(0.110)	(0.062)	(0.117)	(0.097)	(0.050)	(0.058)
R&D Expenditure	0.003	-0.001	0.005***	0.001	0.006**	-0.000
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.000)
R&D Personnel	0.012***	0.003**	0.003***	0.006***	0.001***	0.002***
	(0.004)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
Export	-0.025	0.037**	0.069**	0.061***	-0.002	0.030***
	(0.022)	(0.017)	(0.033)	(0.020)	(0.010)	(0.010)
Competition	-0.024	-0.297***	-0.415***	-0.504***	-0.124***	-0.141***
	(0.056)	(0.043)	(0.085)	(0.060)	(0.027)	(0.027)
N	1677	3484	1621	3482	3518	3510
pseudo R^2	0.091	0.167	0.033	0.101	0.118	0.083

*Notes: The description for dependent variables is shown in the text and the notes for Table 2. City and industry dummies are included in all estimations. The robust standard errors are in parentheses. ***, **, and * indicate that the coefficient is significantly different from zero at the 1 percent, 5 percent and 10 percent levels respectively. N = sample size.*