FDI SPILLOVERS, FIRM HETEROGENEITY AND DEGREE OF OWNERSHIP EVIDENCE FROM CHINESE MANUFACTURING

DRAFT

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Abstract:

Expecting positive spillovers on the domestic economy, the Chinese government attracts foreign investors by various investment programs. The empirical literature on productivity spillovers in transition economies finds however no or even negative spillovers on domestic firms. In this paper we study the direct and indirect effects of foreign direct investment in the Chinese manufacturing industry, using firm-level panel data. Our results indicate that the degree of ownership matters for spillovers. Moreover, we find that firms that are far away from the technological frontier do not benefit from the presence of foreign firms, while firms operating close to the technological frontier enjoy positive spillovers.

1 INTRODUCTION

China evolved in a couple of decades from a command economy to a 'socialist market economy' and became a major player in the world economy. The gradual liberalization of restrictions on foreign direct investment since 1978 has greatly improved the investment environment. Today China is the largest developing country recipient with $61 billion in Foreign Direct Investment (FDI) inflows. China's leaders are convinced that FDI plays a major role in the development of the domestic economy and offer supranational treatment to foreign firms in various ways (e.g. tax incentives that are unavailable to domestic firms). The literature identifies several potential FDI spillover channels, such as imitation, acquisition of human capital, exports, and competition effects. The need for strategic restructuring and the hardening of the soft budget constraints are additional reasons why foreign investment might be beneficial for the host economy in the case of transition economies. Despite the range of positive spillover effects predicted by theory and the strong conviction by policy makers that such spillovers are beneficial, the empirical literature finds no or even negative effects on the productivity of domestic firms in transition and developing economies (e.g. Aitken and Harrison, 1999, Konings, 2001, Smarzynska-Javorcik, 2004, Damijan et al, 2006).

This paper uses a unique panel dataset of almost 5,000 firms in the Chinese manufacturing sector between 2001 and 2004 to analyze whether such spillovers exist. In doing so, we extend the existing literature along various dimensions. First, we investigate whether the degree of ownership matters for the generation of spillovers to domestic firms. Foreign firms that have a majority shareholdership are likely to protect their superior technology better than foreign firms that have a minority stake. Recent evidence by Smarzynska-Javorcik and Spatareanu (2006) suggests that the degree of ownership matters. Second, recent theoretical work by Helpman et al. (2004) and others has highlighted the importance of firm heterogeneity in understanding foreign direct investment. In particular we analyze how the relative position of the domestic firm with respect to the frontier firm matters for absorbing potential spillovers from foreign firms. Finally, this is the first paper that analyzes FDI spillovers in China using micro data. Given the enormous inflow of FDI in China it seems that especially for a country like China it is important to assess whether foreign firms generate externalities to domestic firms.

We find evidence that the degree of ownership matters for spillovers. Moreover, we find that firms that are far away from the technological frontier do not benefit from the presence of foreign firms, while firms operating close to the technological frontier enjoy positive spillovers.

The rest of this paper is organized as follows. In the next section we provide some theoretical and empirical background. Section 3 gives the econometric model that we seek to estimate and discusses the data used. Section 4 reports and discusses the results, section 5 is a concluding one.

2 BACKGROUND

2.1 FDI in China

The promulgation of the Equity Joint Venture Law by the National People's Congress in 1978 marked the first step in the "open door" policy of the Chinese government. Four Special Economic Zones (Shenzhen, Zhuhai, Shantou, and Xiamen) were established in 1980 and were granted more autonomy over their economic policies and institutional environment. Gradually China continued on the path of encouraging foreign direct investment through carefully designed promotion policy measures, especially by creating a business-friendly environment and through preferential treatment of foreign investors. The renowned Southern tour of Deng Xiaoping in 1992 marked the deepening and widening of China's liberalization and was followed by the establishment of numerous coastal open cities and development zones in inland areas were foreign investment enjoyed various tax and non-tax benefits. This resulted in the growing recognition of China's economic potential and sparked off a boom in the number of FDI projects and their value at the beginning of the '90s (See Figure 1). A number of bilateral investment treaties signed in 1992 dealing with issues regarding market access and intellectual property rights protection, and the strong real depreciation of the Chinese Renminbi which made producing in China relatively more attractive, were two factors that further amplified the inflow of foreign capital. The actually utilized value of foreign investment expanded up to more than US$60 billion in 2004. Only the figures for 1999 and 2000 show a slight slowdown. With 60 percent of inward FDI originating from Hong Kong and the other Asian Tigers, this slowdown of foreign investment inflows can be

attributed to the East Asian financial crisis and the slow adjustment of the Chinese domestic economy.[1]

Figure 1: Foreign Direct Investment inflows in China (1991-2004)[2]
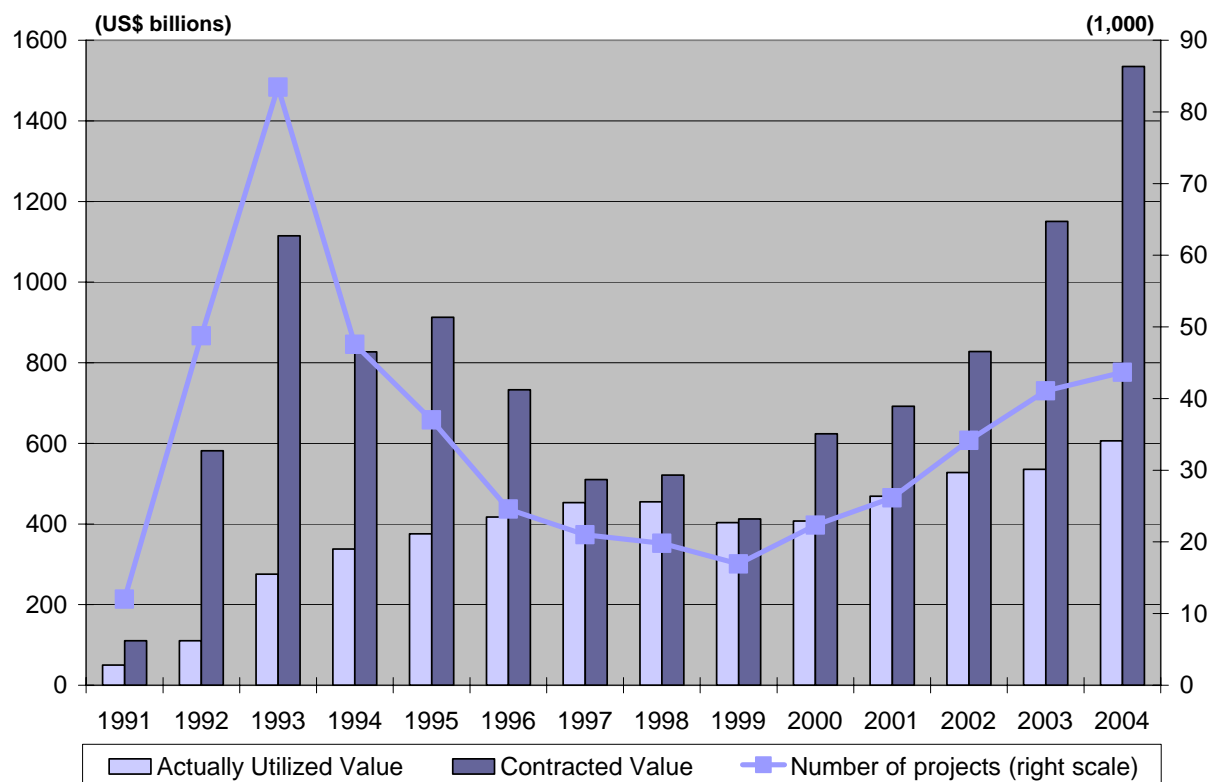
Source: China Statistical Yearbook

2.2   Spillover channels

Expecting positive spillovers on the domestic economy, governments around the world attract foreign investors through various investment programs. The underlying idea is that foreign firms bring in more advanced technological know-how, marketing and managing practices, distribution network, and export contacts. These intangible assets related to FDI are viewed as an engine of a firm's productivity growth. In addition this inflow of foreign capital fastens the process of strategic restructuring by bringing in fresh capital to replace outdated equipment and by updating old production practices. These benefits may not be restricted to

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[1] China Statistical Yearbook 2000

[2] Contracted value is the amount that investors plan to invest over a specified period at the time they apply for approval to invest. The actual or realized value is not bound by the contracted value and is typically much smaller. Government officials have however an incentive to encourage foreign investors to overstate the (not legally binding) contracted value, since the ability of local officials to attract foreign investment is often used by their superiors as an indicator of performance.

the affiliate of the multinational, but spill over to other firms operating in the same region or sector. From the literature we can identify five main spillover channels: demonstration and imitation spillovers (related to products and technology, export, and managerial skills), acquisition of human capital, positive (reduction in X-inefficiencies and reduction of market distortions) and negative competition effects (crowding out), and the hardening of soft budget constraints.[3]

Local firms can learn about the products and technologies brought in by foreign investors, for example through personal contacts, reverse engineering or industrial spying. Such imitation spillovers are more likely to occur in countries where the protection of intellectual property rights (IPR) is insufficient. Chinese imitation of foreign goods is well-known and spread over all kinds of products, from luxury goods, clothes, medicines, music to even the car business. Since China joined the World Trade Organization, it has strengthened its legal framework and amended its IPR laws and regulations to comply with the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). Despite stronger statutory protection, China continues to be a haven for counterfeiters and pirates. On average, 20 percent of all consumer products in the Chinese market are counterfeit. Though Beijing committed to solve the problem, enforcement measures have not been sufficient to prevent massive IPR violations effectively. Several factors play a role in undermining the enforcement measures, including China's reliance on administrative instead of juridical measures to combat IPR infringements, corruption and local protectionism, limited resources and training available to enforcement officials, and lack of public education regarding the economic and social impact of counterfeiting and piracy.

Exports can be considered as another example of demonstration spillovers. Typically foreign firms have already built up an extensive international distribution network and possess the knowledge and experience of international marketing. By simply imitating or collaborating with foreign enterprises, domestic firms may learn how to succeed in foreign markets. In addition domestic firms may benefit from increased market access achieved by the foreign company, such as infrastructure, trade organizations or reductions in trade barriers.

Imitation spillovers may also take place with regard to managerial and organizational practices. This is closely related to another spillover channel, namely the acquisition of

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[3] See Blömstrom and Kokko (1998) for a detailed discussion of the various spillover channels.

human capital. Foreign firms typically invest considerably in the training of their workers. This acquired knowledge may spill over to local firms as employees of foreign firms change jobs or start their own company. Inter-firm mobility accelerates the spread of managing skills and production methods from foreign to domestic companies.

Increased competitive pressure caused by the entry of multinationals forces firms to use their inputs and the existing technology in a more efficient way to secure their market share and their profits. Besides the production gains related to these reductions in X-inefficiency, increased competition also stimulates faster adoption of new technologies and management practices. An additional positive competition effect related to the entry of foreign firms may come from the breakdown of a local monopoly. Such a monopolistic industry is typically characterized by high entry barriers which might be impossible to overcome for local firms. Multinationals on the other hand possess the necessary capital and scale, and the technological knowledge to enter the market and reduce the market distortions. A weakened power of the local monopolist engenders a more competitive and efficient environment in the domestic market.

Aitken and Harrison (1999) argue that the entry of a multinational may also generate negative competition effects on the domestic market. A foreign player who produces for the domestic market may attract demand away from local firms and force the least efficient firms - which are unable to face competition - out of business. A reduction of their market share might induce domestic firms to produce at a less efficient scale. If the fixed costs count for a considerable part of the production costs, average cost curves will be downward sloping, in which case a loss in market share will push firms up their average cost curves. The total spillover effect of increased competition will depend on the influence of the efficiency effect versus the crowding out effect.

An additional benefit from FDI is the potential hardening of budget constraints (e.g. Dewatripont and Maskin, 1995, and Roland, 2002). The soft-budget-constraints (SBC) problem is an important concern in transition countries and is related to the inability of social planners to commit not to bail out money-losing firms (Kornai, 1980). Continued subsidies may slow down the process of restructuring and sectoral reallocation. The presence of foreign

firms and the inflow of foreign capital reduce the financial link between the government and the domestic firms, thereby hardening budget constraints and increasing efficiency.

2.3   Empirical literature

Despite the range of positive spillover effects predicted by theory, the empirical literature finds no or even negative effects on the productivity of domestic firms in developing and transition economies. An overview of the empirical literature can be found in Görg and Greenaway (2003). The few papers that look at the case of Chin confirm the existence of negative spillovers found in other studies. These studies, however, restrict their attention to a particular segment of the market (e.g. electronics and textile industry in Hu and Jefferson; 2002, and state-owned enterprises in Girma et al., 2005), or use industry or provincial data (Li et al., 2001, and Cheung and Lin, 2004 respectively). In this paper we broaden the analysis to all manufacturing sectors and take into account the heterogeneity by using firm-level data in our analysis.

Blömstrom et al. (2000) review the empirical literature and summarize the conditions that have to be fulfilled for externalities to take place. In particular, technology diffusion seems be more than just an automatic consequence of the presence of other firms' knowledge stocks in the same sector or region and depends to a high extent on the absorptive capacity of the recipient firms.[4] To that regard, Kinoshita (2001) looks at the relevance of R&D activities on enhancing the ability to absorb and to adopt the available technology and provides evidence for the Czech Republic that technology spillovers are limited to those firms that are more R&D intensive. Related to this, the amount and the quality of technology transferred through FDI may be dependent on the initial technology level of local firms relative to that of foreign firms. Findlay's (1978) theoretical model predicts that the rate of technological spillovers from FDI is an increasing function of the technological disparity between the backward and advanced region, provided that the gap is not too wide. That is, the further a region lags behind the technological leader, the greater the pressure to make technological progress and to exploit the available opportunities. Using firm-level data for the UK, Griffith et al. (2002) provide empirical evidence for this view of convergence in productivity. They find that establishments further behind the technological frontier experience faster rates of

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[4] The importance of the absorptive capacity was first introduced by Cohen and Levinthal (1989).

growth in total factor productivity and that the increased competitive pressure due to the presence of multinationals speeds up the catching-up rate of domestic firms.

Conversely, Glass and Saggi (1998) reason that if a firm is too far from the technology frontier it might be unable to imitate the available technology and consequently fail to capture the associated efficiency rents. The bigger the gap, the less likely the host country is to have the human capital, physical infrastructure and distribution networks to support inward investment. This decreases the potential for spillovers and lowers the quality of technology transferred. Evidence in favor of this hypothesis is provided by Girma et al. (2001). Firms located further away from the world efficiency standard exhibit a slower productivity spillover rate. On the other hand, Sabirianova et al. (2005) tested the distance-to-the-frontier hypothesis for Russia and the Czech Republic, but their results revealed no catching-up behavior in the domestic economy, not even by those establishments located closer to the frontier.

Instead of restricting a priori the relationship between a firm's absorptive capacity and FDI induced productivity spillovers to be linear, Girma (2005) allows the spillover impact to vary across firms according to their distance to the frontier. Technology spillovers turn out to be an increasing function of the absorptive capacity of the local firms, but they level off after a certain threshold of technological capacity is reached. If a firm is located too far from the frontier, no or even negative FDI spillovers are found.

An additional determinant of the magnitude of FDI induced spillovers that has been proposed by the literature is the degree of ownership.[5] Firms that decide to exploit their technological advantage by providing the world market with their products can choose between exporting, licensing their technology or serving the market through local affiliates. With imperfect markets for technology, and hence high transaction costs to sell technology to outsiders, multinationals prefer to internalize certain transactions to shelter their technological innovations from being copied. While a joint-venture set-up allows a multinational to use its local partner's experience with the domestic markets, consumer preferences, and local business practices, it also increases the risk for undesired leakages of their technologies.[6] The

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[5] Only few studies have paid attention to impact of ownership structure on FDI spillovers: Blomström and Sjöholm (1999), Dimelis and Louri (2001) and Smarzynska-Javorcik and Spatareanu (2006).

[6] WFOEs are allowed in China since the promulgation of the Wholly Foreign-Owned Enterprise Law in 1986. The restrictions on foreign ownership still exist in the Chinese banking sector, where the share of foreign capital is not allowed to be bigger than 25%.

domestic partner comes in close contact with technological innovations and gets access to insider information that it could use in the production of other goods for which it does not cooperate with the multinational. Being confronted with this risk, the parent firm will be discouraged from transferring its most innovative technologies to its affiliate. On the other hand, foreign firms with greater control over their affiliate are better able to protect their intangible assets, and are expected to transfer more sophisticated technologies to their subsidiaries.[7] On that account fewer FDI spillovers are expected from the presence of firms with a foreign majority not only because the technology is better protected, but also because domestic firms might not have the necessary absorptive capacity to copy the highly sophisticated technology that is transferred.

3   DATA AND ECONOMETRIC APPROACH

3.1   Data

The data used in this paper are drawn from the Oriana CD-ROM (version October 2005) compiled by Bureau van Dijk, which contains public and private financial company information for the Asia-Pacific region. The companies included in the database are either publicly listed or satisfy at least one of the following size criteria: minimum number of employees is 150, or annual turnover or total assets at least 10 million and 20 million USD, respectively. For the People's Republic of China the original dataset covers an unbalanced panel of 11,377 firms over the period 2001 and 2004. We restrict our attention to the manufacturing sector, based on the US SIC 1987 classification (sectors 20-39). The number of observations is further reduced to 4,938 firms due to a lot of missing values on some of the input factors. Table 1 reports summary statistics for the basic variables employed in this paper. Sales and value added are deflated by a provincial producers' price index of industrial products. Capital is deflated by a provincial price index of investment in fixed assets, which takes into account the actual purchasing prices or balancing prices of investment in fixed assets. All price indices are taken from various editions of China Statistical Yearbook. The descriptive statistics reveal that foreign firms are not only larger relative to domestic plants in terms of employment, sales and value added, but they are also more capital intensive and enjoy higher productivity. However, these differences may result from a selection bias, which

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[7] See Ramachandran (1993)

reflects the tendency of foreign firms to acquire more productive local firms or to invest in higher productive sectors and regions.

Table 1: Summary statistics for domestic versus foreign manufacturing plants in China

	Mean		Minimum		Maximum	
	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign
Number of employees	1,763	1,453	15	39	137,962	67,200
Sales	63,371	133,394	971	18,419	3,656,775	3,658,313
Value added	10,002	20,925	84	713	863,275	768,264
Value added per worker	8.83	21.77	0.16	1.26	907.36	287.05
Sales per worker	68.92	153.53	0.73	6.25	6,154.42	1,427.34
Capital per worker	26.03	65.73	0.01	0.42	3,374.67	930.22
Labour productivity	69.29	154.32	0.73	6.25	6,154.42	1,428.02

Notes: All variables are expressed in thousands of US Dollars (except for the number of employees), using a provincial price index to deflate.

An overview of the sectoral and regional distribution of foreign firms in China is given in Appendix A en B. As Appendix A shows nearly 90% of foreign capital is located in the coastal region of China, and more precisely in three provinces: Shanghai, Guangdong and Jiangsu which received more than half of total FDI in China. This geographical concentration is partially attributable to the FDI promotion policies adopted in the past. At the beginning of the liberalization of the Chinese economy, the government strategically directed FDI to the Special Economic Zones (SEZs) located in the Guangdong and Fujian provinces. Later on similar FDI policies were extended to other coastal industrial cities and ports, such as Shanghai, the Pearl River Delta, and the Yangtze Delta. Only since the beginning of the nineties China gradually started to target its inland. However, as Cheng and Kwan (2000) argue, good infrastructure is another important determinant in foreign investors' location decisions. In particular the inland regions have inadequate and undeveloped infrastructure networks and facilities, a fact which reinforces the concentration of foreign capital and technology in the eastern part of China. Appendix B displays that also the sectoral composition of FDI in China is unevenly distributed. Until the end of the eighties the primary sector attracted the biggest share of FDI. Afterwards, the Chinese manufacturing sector fast became the most important sector for foreign investors. At this moment it accounts for more

than 70% of the total actually utilized value of FDI in China.[8] In addition, the investment focus moved from textile processing, chemicals, and mechanical and electronics industries to more technically advanced sectors. This shifting sectoral composition reflects changes in the origin of foreign investors. In the eighties the major part of inward FDI originated from Chinese investors based in Hong Kong, Macau and Taiwan. These overseas investors were meanly seeking to exploit the relatively low labour cost in the SEZs for export processing. Since the beginning of the nineties China attracted increasingly more technologically advanced Western and Japanese companies, interested in serving the huge domestic market through local production.

3.2 Econometric approach

We start from a general neoclassical production function,

$$Y_{it} = A_{it} F_i \left(L_{it}^{\alpha_L} K_{it}^{\alpha_K} M_{it}^{\alpha_M} \right) \tag{1}$$

where i and t indicate industry and time respectively. Y stands for output, while L, K and M represent the inputs used in production, being labour, physical capital stock, and materials respectively. The index A_{it} is a measure of technical efficiency or Total Factor Productivity (TFP) of firm i at time t. We assume TFP to be a function of foreign participation and various spillover effects, and control for sector-, region-, and time-specific determinants of technical efficiency:

$$TFP_{it} = G_i \left(FDI_i, Spillover_{jt}, d_j, d_c, d_t \right) \tag{2}$$

The underlying idea is that foreign firms utilize more advanced technology and a more efficient organizational structure, which increases the efficiency of their production process. Additionally, as discussed in the previous sections, technical efficiency improvements through foreign capital injection are usually not limited to the receiving firm, but are likely to spillover to firms that come in contact with the multinational.

Based on equations (1) and (2) we can estimate the direct and indirect spillover effects of FDI at the firm level:

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[8] China Statistical Yearbook 2005

$$y_{it} = \alpha_L l_{it} + \alpha_K k_{it} + \alpha_M m_{it} + \beta_1 Foreign_i + \beta_2 Spillover_{jt} + \beta_3 Spillover_{jt} \times Foreign_i + d_j + d_c + d_t + \varepsilon_{it}$$

(3)

where the small letters stand for the natural logarithms of the respective variables and the α's represent the elasticity of output with respect to the inputs. y_{it} is measured as the value added of firm i at time t deflated by a provincial producers' price index of industrial products, l_{it} is the number of workers employed by firm i at time t, k_{it} represents the tangible fixed assets of firm i at time t deflated by a provincial price index of investment in fixed assets, and m_{it} is measured by the cost of the goods sold less the cost of employees, deflated by a provincial producers' price index of industrial products.

The remaining variables in regression (3) allow us to analyze the various factors that affect the technical efficiency of a firm. *Foreign$_i$* is a dummy variable that is included to capture the direct effect of foreign capital injection in the domestic firm or affiliate.[9] In the first step of our analysis we classify a firm as being foreign when a positive percentage of the firm's asset is owned by foreign shareholders. Since foreign firms are assumed to benefit from technological advantages, we expect a productivity boost associated with the inflow of foreign capital and a positive coefficient β_1. To evaluate the indirect efficiency spillover impact at the sector level, the regression is extended by the variable *Spillover$_{jt}$*. *Spillover$_{jt}$* is a measure for the presence of multinationals in the same sector and is defined as the share of foreign value added in total value added at the 3-digit US SIC87 industry-level. Depending on whether or not the negative competition effect related to foreign investment dominates the positive imitation effect, β_2 will be either negative or positive. It might however be possible that foreign- and domestic-owned firms benefit in a different way from the presence of other multinationals in the same sector. Therefore we interact the foreign ownership dummy with the spillover variable (*Spillover$_{jt}$* x *Foreign$_i$*). Finally, the dummy variables d_j, d_c, and d_t are added to take into account unobserved industry-, region-, or time varying factors. This allows us to control for the fact that the more productive firms, sectors or regions might attract more foreign capital.[10]

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[9] The Oriana database does not allow us to see changes in ownership structure. The nationality of a shareholder is fixed over time and determined at the moment of reporting (i.e. year 2005).
[10] Year dummies take into account economy-wide shocks, while regional dummies and industry dummies control for productivity changes specific to a particular city or industry respectively (for instance, those resulting from improvements in infrastructure).

In this study we are particularly interested in the impact of the ownership structure on the magnitude of spillovers. To analyze this question into further detail, we differentiate in our second regression between foreign minority firms and foreign majority firms:

$$
\begin{aligned}
y_{it} = {} & \alpha_L l_{it} + \alpha_K k_{it} + \alpha_M m_{it} + \beta_1 Foreign\_Min_i + \beta_2 Foreign\_Maj_i + \\
& \beta_3 Spillover\_Min_{jt} + \beta_4 Spillover\_Maj_{jt} + \beta_5 Spillover\_Min_{jt} \times Foreign\_Min_i \quad (4) \\
& + \beta_4 Spillover\_Maj_{jt} \times Foreign\_Maj_i + d_j + d_c + d_t + \varepsilon_{it}
\end{aligned}
$$

The reason behind this distinction relates to the expected difference in spillovers related to WFOEs, and joint-ventures between foreign firms and their Chinese partners, as discussed in the previous section. The more a multinational controls the establishment, the greater its ability to protect its technology from spilling over to other plants. Hence we replace the dummy $Foreign_i$ with two dummies $Foreign\_Min_i$ and $Foreign\_Maj_i$, which equal one if the share of foreign capital lies between 10 and 50%, and above 50% respectively. While a WFOE will be faster inclined towards using its most efficient production methods, the higher risk of undesired copying inhibits the parent company of a joint-venture to transfer its know-how to its affiliates. That is, production is presumed to be more efficient in the case of foreign majority (β_2 bigger than β_1). Since also the indirect spillovers are expected to be different according to the degree of foreign participation, we distinguish between spillovers from foreign minority and foreign majority firms. We presume that the competition effect will be fiercer in the case of foreign majority, since these firms are less afraid to use their latest technological innovations, so that they are more likely to outperform local producers. In the case of foreign minority control the imitation spillovers might dominate the competition impact.

The final contribution of this paper to the literature is related to the impact of the distance to the frontier on spillovers. To analyze the importance of the absorptive capacity of a firm we follow the method introduced by Griffith et al (2002). They assume that the total factor productivity of a firm relative to the frontier in a particular industry can be modelled as an Error Correction Model (ECM):

$$
\Delta \ln TFP_{it} = \beta \Delta \ln TFP_{jt}^F + \delta \ln \left(\frac{TFP_i}{TFP_j^F} \right)_{t-1} + u_{it} \quad (5)
$$

where TFP_{jt}^{F} represents the total factor productivity of the most efficient firm at time t in industry j at the 3-digit US SIC87 level. The evolution of technological progress, as captured by the first term, is expected to have a direct impact on the efficiency of non-frontier firms. The second term in the equation denotes the technological gap between a non-frontier firm and the technology frontier in industry j at time t-1, and can be viewed as a measure for the absorptive capacity of a firm. Hence, the coefficient δ can be interpreted as the average catching-up rate in the manufacturing industry.

To analyze the relationship between a firm's absorptive capacity and FDI induced productivity spillovers we continue in two steps. First we estimate the log-linear transformation of the neoclassical production function in equation (1) to obtain estimates of the firm-specific total factor productivity:[11]

$$y_{it} = \alpha_L l_{it} + \alpha_K k_{it} + \alpha_M m_{it} + d_j + d_c + d_t + \varepsilon_{it} \tag{6}$$

In a second step we relate these estimated TFP-levels to the efficiency frontier and the presence of foreign firms, using specification (5):

$$\begin{aligned}
\Delta \ln TFP_{it} = {} &\gamma \Delta \ln TFP_{jt}^{F} + \delta \ln\left(TFP_i / TFP_j^F\right)_{t-1} + \beta_1 Foreign_i + \beta_2 Spillover_{jt-1} \\
&+ \beta_3 Spillover_{jt-1} \times Foreign_i + \beta_3 Spillover_{jt-1} \times \ln\left(TFP_i / TFP_j^F\right)_{t-1} \\
&+ d_j + d_c + d_t + u_{it}
\end{aligned} \tag{7}$$

The most interesting variable is the last term in equation (7), namely the interaction term between the technology gap and the spillovers. This variable indicates whether spillovers depend on the capacity of a firm to absorb the technological innovations that are used in the production process of foreign-owned establishments. If our distance-to-the-frontier hypothesis is confirmed, β_3 should be positive, indicating that firms closer to the technology frontier possess the necessary knowledge to learn from multinationals. Since domestic firms might learn both from foreign firms producing in the same sector as from multinationals located in the same region, we run regression (7) twice. Hence we define the variable $Spillover_{jt}$ both at the sectoral and regional level. Similar to the definition of sectoral spillovers, we measure regional spillovers by the share of a city's value added produced by foreign firms. Since the

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[11] Since this TFP measure is simply the regression residual it depends crucially on the goodness of fit of the model.

average Chinese province is much bigger than the average European country, we decided to identify a region at a more narrowly defined level, i.e. the city level instead of the provincial level, which is normally used in empirical studies.

Analogously to the first part of our empirical analysis, we look at the impact of the ownership structure of foreign firms on the absorptive capacity of local firms:

$$
\begin{aligned}
\Delta \ln TFP_{it} = {} & \gamma \Delta \ln TFP_{jt}^{F} + \delta \ln \left(TFP_{i} \big/ TFP_{j}^{F} \right)_{t-1} + \beta_{1} Foreign\_Min_{i} + \beta_{2} Foreign\_Maj_{i} \\
& + \beta_{3} Spillover\_Min_{jt-1} + \beta_{4} Spillover\_Maj_{jt-1} + \beta_{3} Spillover\_Min_{jt-1} \times Foreign\_Min_{i} \\
& + \beta_{4} Spillover\_Maj_{jt-1} \times Foreign\_Maj_{i} + \beta_{5} Spillover\_Min_{jt-1} \times \ln \left(TFP_{i} \big/ TFP_{j}^{F} \right)_{t-1} \\
& + \beta_{6} Spillover\_Maj_{jt-1} \times \ln \left(TFP_{i} \big/ TFP_{j}^{F} \right)_{t-1} + d_{j} + d_{c} + d_{t} + u_{it}
\end{aligned}
\tag{8}
$$

4 RESULTS

4.1 Spillovers and the role of ownership structure

Table 2 shows the results for the FDI induced sectoral spillovers and the importance of the degree of ownership.[12] In the first column the estimation of equation (3) is presented, while in the second column we make a distinction between foreign minority firms (foreign share in the Chinese affiliate between 10 and 50%) and foreign majority firms (share of more than 50%), and look at the different spillover effects they engender. First of all, our results illustrate significant differences in the performance of domestic and foreign firms. The estimations reveal that after controlling for firm-specific aspects, the injection of foreign capital generates a direct productivity boost to the receiving firm. The point estimate of 0.152 implies that with the same inputs, foreign firms produce about 15.2% more than their domestic counterparts. When we distinguish between foreign minority and foreign majority firms, we see however that this efficiency increase can be completely ascribed to the foreign firms that have a majority control over their Chinese affiliate. These findings confirm our expectations, and suggest that the parent company is reluctant to transfer its know-how to joint-ventures over which they do not have full control.

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[12] We clustered standard errors to take into account a potential correlation between error terms.

Table 2: Spillovers and the role of ownership structure (OLS estimation) [a]

log(valued added) as dependent variable	(1) [b]	(2) [c]
n	0.233	0.230
	(0.011)*	(0.011)*
k	0.357	0.358
	(0.009)*	(0.009)*
m	0.320	0.325
	(0.011)*	(0.011)*
Foreign	0.152	-
	(0.045)*	
Foreign_Min	-	0.074
		(-0.062)
Foreign_Maj	-	0.145
		(0.050)*
Spillover	-0.167	-
	(0.053)*	
Spillover_Min	-	-0.004
		(-0.075)
Spillover_Maj	-	-0.422
		(0.088)*
Spillover x *Foreign*	0.211	-
	(0.147)	
Spillover_Min x *Foreign_Min*	-	0.717
		(0.257)*
Spillover_Maj x *Foreign_Maj*	-	0.141
		(0.266)
Observations	8612	8612
Adjusted R-squared	0.820	0.819

[a] All regressions include sector, region, and time dummies - Robust standard errors in parentheses - * significant at 1%.
[b] Estimation of equation (3): *Foreign* is a dummy equalling one if a positive percentage of the firm's asset is owned by foreign shareholders.
[c] Estimation of equation (4): Differentiation between foreign minority firms and foreign majority firms, with the share of foreign capital being between 10 and 50%, and more than 50% respectively.

There is however a clear negative indirect spillover effect associated with the presence of foreign firms in the same sector, as indicated by the negative coefficient on the variable *Spillover*$_{jt}$. A 10-percentage-point increase in the share of foreign investment in a particular industry leads to an average decrease in the production by 1.67 percentage points. Because of the specific nature of joint-ventures, technology is expected to spill over much more easily than in the case of WFOEs. The domestic plant can learn from the experience of its foreign partner and this knowledge might get distributed through for instance the mobility of workers.

However, our results in the second column show that local firms seem to be unable to capture the benefits from the presence of foreign minority firms in the same sector. Instead, there is a negative and highly significant competition effect induced by foreign majority firms. The cost advantages these multinationals have, allow them to attract demand away from local producers. This forces domestic firms to reduce their production and pushes them up their average cost curve. These findings reflect that on average the negative competition effect is stronger than the positive knowledge spillover effects associated with the presence of multinationals. In addition, this might be an indication that, notwithstanding the weak Chinese IPR-protection system, multinationals seems to be able to protect their strategic technological and managerial advantages from being imitated.

Foreign firms, on the other hand, do not seem to suffer from increased competitive pressure in their sector. On the contrary, our results reveal that other foreign firms benefit from the presence of foreign minority joint-ventures in the same sector. An increase from 0 to 10 percent in the share of foreign minority firms in the same industry boosts the production of other foreign plants with a minority share in their Chinese affiliate with 7.13 [=(-0.004+0.717)*10] percentage points.[13]

4.2   Distance to the frontier

As explained in Section 2.3, the negative results for domestic firms might signal an insufficient absorptive capacity which deprives them of assimilating the existing knowledge. To analyze this heterogeneity in FDI response across firms we look at the impact of the technology gap, and the relation between efficiency spillovers and a firm's distance to the frontier. Before moving to the results of our regression, we have a look at the average TFP level and TFP growth across industries in Table 3. In most sectors the average TFP level of foreign firms is higher than for their domestic counterparts. On the other hand, in most sectors we can observe a faster TFP growth for domestic firms than for multinationals. This first indication of the fact that on average plants located further away from the frontier are catching up to the prevailing technological standard at a faster rate, is indeed confirmed by the results

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[13] We must be careful not to look separately at the *t*-statistic of the estimates of the coefficients on *Spillover_Min* and *Spillover_Min* x *Foreign_Min* to conclude whether we can reject the null hypothesis of both coefficients being equal to zero. In fact, the F statistic of the joint hypothesis is 4.09, so we certainly reject the null hypothesis at the 5% level.

of our distance-to-the-frontier regression in Table 4. The negative coefficient on $\ln\left(TFP_i/TFP_j^F\right)_{t-1}$ tells us that the closer a firm is located to the frontier at time *t-1*, the lower its TFP growth ceteris paribus. This is evidence for the convergence in efficiency among firms and a reflection of the bigger potential for efficiency improvements backward firms can still realize.

Table 3: Average TFP levels and TFP growth by sector and ownership

US SIC sector	TFP level			TFP growth		
	Foreign firms	Domestic firms	Difference	Foreign firms	Domestic firms	Difference
20	0.27	-0.03	0.30	-0.05	-0.03	-0.03
21	-0.28	0.01	-0.29	0.24	-0.07	0.31
22	0.02	0.00	0.02	-0.04	-0.03	-0.01
23	0.22	-0.01	0.24	-0.18	-0.02	-0.16
24	-0.20	0.02	-0.22	-	0.10	-
25	0.02	0.00	0.02	-0.02	-0.01	-0.01
26	0.16	-0.02	0.18	-0.20	0.03	-0.23
27	0.10	-0.01	0.11	-0.15	0.05	-0.20
28	0.32	-0.03	0.35	0.01	0.02	-0.01
29	0.15	-0.02	0.18	0.02	0.13	-0.10
30	0.10	-0.01	0.11	-0.11	0.00	-0.11
31	-0.03	0.00	-0.03	0.09	0.05	0.04
32	0.11	-0.01	0.12	0.21	0.08	0.13
33	0.07	0.00	0.07	-0.01	0.04	-0.04
34	0.07	-0.01	0.08	0.03	0.07	-0.04
35	0.03	0.00	0.03	-0.07	-0.03	-0.05
36	0.05	-0.01	0.06	0.00	-0.04	0.04
37	0.28	-0.05	0.33	0.00	0.01	-0.01
38	0.19	-0.02	0.21	0.01	0.03	-0.02
39	0.10	-0.01	0.11	-0.25	-0.01	-0.24

Note: TFP is the residual taken from the following regression:
$$y_{it} = \alpha_L l_{it} + \alpha_K k_{it} + \alpha_M m_{it} + d_j + d_c + d_t + \varepsilon_{it}$$

The regression results in Table 4 further indicate that technological efficiency improvements at the frontier level have a positive and significant direct effect on the TFP growth in non-frontier firms. Nevertheless, an increase in efficiency of 0.03 percentage points in response to a 10 percentage point expansion of the technology frontier is economically negligible. In addition, the presence of foreign firms in the same sector at time *t-1* does not seem to have an impact on TFP growth on average.

Table 4: Distance to the frontier (OLS estimation)

$\Delta \ln TFP_{it}$ as dependent variable	Sectoral spillovers	Regional spillovers
$\Delta \ln TFP_{jt}^{F}$	0.003	0.003
	(0.001)*	(0.001)*
$\ln\left(TFP_i \big/ TFP_j^F\right)_{t-1}$	-0.256	-0.195
	(0.019)*	(0.017)*
Foreign	0.011	0.005
	(0.038)	(0.039)
Spillover$_{t-1}$	0.070	-0.060
	(0.126)	(0.112)
Spillover$_{t-1}$ x *Foreign$_{t-1}$*	0.092	0.079
	(0.132)	(0.105)
$Spillover_{t-1} \times \ln\left(TFP_i \big/ TFP_j^F\right)_{t-1}$	0.263	-0.003
	(0.083)*	(0.080)
Observations	2923	2923
R-squared	0.133	0.122

Note: All regressions include sector, region, and time dummies - Robust standard errors in parentheses - * significant at 1%.

Our main interest lies in the interaction term $Spillover_{t-1} \times \ln\left(TFP_i \big/ TFP_j^F\right)_{t-1}$, which gives us information on the impact of the absorptive capacity on the magnitude of spillovers. The absorptive capacity, which is measured by a firm's position relative to the frontier, is on average higher for the foreign plants (41%) than for domestic plants (36%). The positive and statistically significant coefficient on $Spillover_{t-1} \times \ln\left(TFP_i \big/ TFP_j^F\right)_{t-1}$ is a confirmation of the hypothesis of Glass and Saggi (1998) which postulates that the smaller the distance to the frontier the more a firm is able to benefit from the presence of multinationals in the same sector.[14] When we distinguish between foreign minority and foreign majority firms (Table 5), we see that the absorptive capacity is only relevant for knowledge spilling over from joint-ventures in which foreigners have only a minority stake. Finally, when we run the regression

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[14] The F statistic of the joint hypothesis that the coefficients on $Spillover_{t-1}$ and $Spillover_{t-1} \times \ln\left(TFP_i \big/ TFP_j^F\right)_{t-1}$ are both equal to zero is 15.27 (5.82 for foreign firms), so we certainly reject the null hypothesis at the 1% level.

with the variable *Spillover*$_{t-1}$ defined at the regional level, we find no indication of investment spillovers.

Table 5: Distance to the frontier and the role of ownership structure (OLS estimation)

$\Delta \ln TFP_{it}$ as dependent variable	Sectoral spillovers	Regional spillovers
$\Delta \ln TFP_{jt}^{F}$	0.003	0.003
	(0.001)*	(0.001)*
$\ln\left(TFP_i / TFP_j^{F}\right)_{t-1}$	-0.239	-0.192
	(0.019)*	(0.017)*
Foreign_Min	-0.015	0.01
	(0.057)	(0.053)
Foreign_Maj	0.038	0.044
	(0.045)	(0.043)
Spillover_Min$_{t-1}$	0.204	-0.123
	(0.203)	(0.226)
Spillover_Maj$_{t-1}$	-0.115	-0.012
	(0.194)	(0.151)
Spillover_Min$_{t-1}$ x *Foreign_Min*$_{t-1}$	0.431	0.208
	(0.270)	(0.174)
Spillover_Maj$_{t-1}$ x *Foreign_Maj*$_{t-1}$	-0.119	-0.139
	(0.246)	(0.153)
$Spillover\_Min_{t-1} \times \ln\left(TFP_i / TFP_j^{F}\right)_{t-1}$	0.331	-0.123
	(0.108)*	(0.163)
$Spillover\_Maj_{t-1} \times \ln\left(TFP_i / TFP_j^{F}\right)_{t-1}$	0.003	0.030
	(0.146)	(0.101)
Observations	2923	2923
R-squared	0.134	0.124

Note: All regressions include sector, region, and time dummies - Robust standard errors in parentheses - * significant at 1%.

5 CONCLUSION

In this paper we used a unique panel dataset of Chinese firms to analyze whether foreign investment in the Chinese economy generates positive spillovers to the domestic economy. Our results reveal in the first place significant differences in the performance of domestic and foreign firms, and the importance of distinguishing according to the ownership structure when looking at the impact of foreign investment. It turned out that the parent company is reluctant to transfer its know-how to joint-ventures over which they do not have

full control. When a multinational owns a majority stake in the affiliate, the risk of undesired knowledge spillovers is reduced to a minimum. Because of this these multinationals have the possibility to apply their most advanced production techniques, hereby generating negative competition effects on the local market. Second, we analyzed how the relative position of the domestic firm with respect to the frontier firm matters for absorbing potential spillovers from foreign firms. Our results confirm the hypothesis of Glass and Saggi (1998) that the smaller the distance to the frontier the more a firm is able to benefit from the presence of multinationals in the same sector.

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Appendix A: Regional Distribution of FDI in China

	# of firms	# of foreign firms	Concentration of foreign firms[a]	Distribution of foreign firms[b]
SHANGHAI	282	84	29.79%	19.13%
BEIJING	95	20	21.05%	4.56%
TIANJIN	122	24	19.67%	5.47%
LIAONING	145	21	14.48%	4.78%
GUANGDONG	616	80	12.99%	18.22%
JIANGSU	746	79	10.59%	18.00%
FUJIAN	209	19	9.09%	4.33%
HAINAN	12	1	8.33%	0.23%
JILIN	41	3	7.32%	0.68%
ANHUI	87	6	6.90%	1.37%
SHANXI	50	3	6.00%	0.68%
INNERMONGOLIA	40	2	5.00%	0.46%
ZHEJIANG	685	34	4.96%	7.74%
HEBEI	205	10	4.88%	2.28%
HEILONGJIANG	44	2	4.55%	0.46%
SICHUAN	200	9	4.50%	2.05%
SHANDONG	675	30	4.44%	6.83%
GUANGXI	82	3	3.66%	0.68%
GUIZHOU	28	1	3.57%	0.23%
HUBEI	128	4	3.13%	0.91%
YUNNAN	43	1	2.33%	0.23%
HUNAN	68	1	1.47%	0.23%
HENAN	171	2	1.17%	0.46%
XINJIANG	22	0	0.00%	0.00%
SHAANXI	66	0	0.00%	0.00%
QINGHAI	7	0	0.00%	0.00%
NINGXIA	13	0	0.00%	0.00%
JIANGXI	35	0	0.00%	0.00%
GANSU	21	0	0.00%	0.00%
Total	4938	439	8.89%	100%

Notes: (a) The share of foreign plants in the total number of plants in a particular province.
(b) The distribution of foreign firms across the country.

Appendix B: Sectoral distribution of FDI in China

US SIC	Description	# of firms	% of Foreign firms	% of Foreign minority	% of Foreign majority
20	Food and kindred products	503	7.55%	1.59%	4.97%
21	Tobacco products	24	4.17%	0.00%	4.17%
22	Textile mill products	505	1.58%	0.59%	0.99%
23	Apparel and other textile products	238	4.62%	0.42%	3.78%
24	Lumber and wood products	46	8.70%	2.17%	6.52%
25	Furniture and fixtures	30	6.67%	0.00%	6.67%
26	Paper and allied products	166	9.04%	1.81%	6.63%
27	Printing and publishing	24	12.50%	4.17%	8.33%
28	Chemicals and allied products	640	7.50%	1.72%	5.31%
29	Petroleum and coal products	78	10.26%	6.41%	3.85%
30	Rubber and miscellaneous plastics products	178	13.48%	3.37%	10.11%
31	Leather and leather products	116	6.03%	0.86%	5.17%
32	Stone, clay, and glass products	208	5.29%	1.44%	3.85%
33	Primary metal industries	495	4.65%	1.41%	3.23%
34	Fabricated metal products	169	11.83%	4.73%	6.51%
35	Industrial machinery and equipment	433	10.62%	1.62%	8.31%
36	Electronic and other electric equipment	638	18.18%	2.66%	13.79%
37	Transportation equipment	301	13.29%	7.64%	5.32%
38	Instruments and related products	64	12.50%	1.56%	10.94%
39	Miscellaneous manufacturing industries	82	7.32%	1.22%	6.10%
	Total	4938	8.89%	2.17%	6.20%

Note: A firm is a foreign firm when a positive percentage of the firm's asset is owned by foreign shareholders. Foreign minority firms and foreign majority firms have a share of foreign capital between 10 and 50%, and more than 50% respectively.