DISCUSSION PAPER SERIES

No. 6573

FDI SPILLOVERS IN THE CHINESE MANUFACTURING SECTOR: EVIDENCE OF FIRM HETEROGENEITY

Filip Abraham, Jozef Konings and Veerle Slootmaekers

INDUSTRIAL ORGANIZATION and INTERNATIONAL TRADE

Centre for Economic Policy Research

www.cepr.org

Available online at: **www.cepr.org/pubs/dps/DP6573.asp**

ISSN 0265-8003

FDI SPILLOVERS IN THE CHINESE MANUFACTURING SECTOR: EVIDENCE OF FIRM HETEROGENEITY

Filip Abraham, Catholic University of Leuven
Jozef Konings, Catholic University of Leuven and CEPR
Veerle Slootmaekers, Catholic University of Leuven

Discussion Paper No. 6573
November 2007

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 6573

November 2007

ABSTRACT

FDI Spillovers in the Chinese Manufacturing Sector: Evidence of firm heterogeneity*

We use a new longitudinal data set of more than 15,000 Chinese manufacturing plants to show that the direct and indirect effects of foreign direct investment on measured firm level productivity depend on a number of firm specific features and institutional factors. We find that domestic firms engaged in a joint-venture with a foreign partner are on average more productive, as well as exporting plants and plants located in special economic zones. In addition, domestic firms benefit from horizontal spillovers from foreign firms on average. However, these spillovers depend on the structure and origin of ownership as well as on specific characteristics of the special economic zones. First, spillovers are less likely to occur from fully foreign owned firms than from joint-ventures. Second, spillovers from foreign direct investment originating from oversees Chinese (Hong Kong, Macau and Taiwan) are stronger than from the rest of the world. Third, spillovers are higher in the special economic zone aimed at attracting foreign capital to fasten the development of China's own high tech industries.

JEL Classification: F21 and L2
Keywords: China, firm heterogeneity, productivity and spillovers

Filip Abraham
Faculty of Business and Economics
Katholieke Universiteit Leuven
Naamsestraat 69
3000 Leuven
Belgium
Email: filip.abraham@rec.kuleuven.be

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=111264

Jozef Konings
Faculty of Business and Economics
Katholieke Universiteit Leuven
Naamsestraat 69
3000 Leuven
Belgium
Email: joep.konings@econ.kuleuven.be

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=126486

Veerle Slootmaekers
Faculty of Business and Economics
Katholieke Universiteit Leuven
Naamsestraat 69
3000 Leuven
Belgium
Email:
Veerle.Slootmaekers@econ.kuleuven.
be

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=167500

* We would like to thank Mary Amiti, Damiaan Persyn, Jan De Loecker, Barry Naughton, Taotao Chen, and participants at the GEP conference in Nottingham, CEDI conference at Brunel University, CES conference in Shanghai, Summer school at CERDI, ETSG conference in Vienna. The paper has benefited from presentations at LICOS, Catholic University of Leuven, IMF, Université Catholique de Louvain, University of Ljubljana, and Fudan University Shanghai. Finally we would like to thank the Department of Economics of Fudan University Shanghai for its hospitality and facilities while Veerle Slootmaekers was visiting. Financial support from the Catholic University of Leuven and LICOS is gratefully acknowledged.

Submitted 09 November 2007

FDI spillovers in the Chinese manufacturing sector: Evidence of firm heterogeneity*

Filip Abraham†, Jozef Konings‡ and Veerle Slootmaekers§
Catholic University of Leuven - November 2007

Abstract

We use a new longitudinal data set of more than 15,000 Chinese manufacturing plants to show that the direct and indirect effects of foreign direct investment on measured firm level productivity depend on a number of firm specific features and institutional factors. We find that domestic firms engaged in a joint-venture with a foreign partner are on average more productive, as well as exporting plants and plants located in special economic zones. In addition, domestic firms benefit from horizontal spillovers from foreign firms on average. However, these spillovers depend on the structure and origin of ownership as well as on specific characteristics of the special economic zones. First, spillovers are less likely to occur from fully foreign owned firms than from joint-ventures. Second, spillovers from foreign direct investment originating from overseas Chinese (Hong Kong, Macau and Taiwan) are stronger than from the rest of the world. Third, spillovers are higher in the special economic zone aimed at attracting foreign capital to fasten the development of China's own high-tech industries.

JEL classification: F21, L2

Keywords: spillovers, firm heterogeneity, productivity, China

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

*We would like to thank Mary Amiti, Damiaan Persyn, Jan De Loecker, Barry Naughton, Taotao Chen, and participants at the GEP conference in Nottingham, CEDI conference at Brunel University, CES conference in Shanghai, Summer school at CERDI, ETSG conference in Vienna. The paper has benefited from presentations at LICOS, Catholic University of Leuven, IMF, Université Catholique de Louvain, University of Ljubljana, and Fudan University Shanghai. Finally we would like to thank the Department of Economics of Fudan University Shanghai for its hospitality and facilities while Veerle Slootmaekers was visiting. Financial support from the Catholic University of Leuven and LICOS is gratefully acknowledged.

†Catholic University of Leuven, Department of Economics & Leuven Center for Global Governance Studies

‡Catholic University of Leuven, Department of Economics & LICOS Centre for Institutions and Economic Performance

§Catholic University of Leuven, Department of Economics & LICOS Centre for Institutions and Economic Performance. Contact: Debériotstraat 34 - bus 3511, 3000 Leuven, Belgium; E-mail: Veerle.Slootmaekers@econ.kuleuven.be

of restrictions on Foreign Direct Investment (FDI) since 1978 has greatly improved the investment environment. Today China is the largest developing country recipient with more than $60 billion in FDI inflows. China's leaders are convinced that FDI plays a major role in the development of the domestic economy and have been offering supranational treatment to foreign firms in various ways (e.g. tax incentives that are unavailable to domestic firms).[1] Despite the range of positive spillover effects predicted by theory and the strong conviction by policy makers that such externalities are beneficial, the empirical literature is ambiguous on the effects of FDI on domestic productivity in developing and transition countries.[2] For developed countries, the empirical evidence is fairly consistent in showing that the productivity of domestically owned firms is positively related to foreign presence.[3]

In this paper we use a rich panel dataset of more than 15,000 plants in the Chinese manufacturing sector between 2002 and 2004. Besides the typical data obtained from balance sheets and income statements, we are able to track down the country of origin of FDI and the degree of foreign ownership. This valuable information allows us, first of all, to take into account the degree of ownership and distinguish between Sino-foreign joint ventures (JVs) and wholly foreign owned enterprises (WFOEs) in our analysis.[4] Besides, we have information on whether or not, and how much a plant is exporting. The existing literature so far has paid little attention to spillovers through exports. In the following section we will focus in particular on the various channels through which export spillovers may occur.

Since our approach relies on measuring the effects of FDI on domestic firms' total factor productivity (TFP), we take into account potential pitfalls in estimating and interpreting TFP as pointed out by Klette and Griliches (1996) and more recently by Katayama, Lu and Tybout (2003) among others. We will estimate production functions using Olley and Pakes' (1996) approach for correcting for simultaneity between input choices and productivity shocks. In addition we report in our robustness checks a number of different approaches that take into account the effect of markups. In section 5 we will estimate the productivity levels using a Cobb-Douglas production function. Given that a production function defines the maximum output attainable from a given vector of input, we need to assume that plants behave as profit maximizing market players. State owned enterprises (SOEs), however, seldom operate as independent business entities responding solely to

[1]On January 1st 2008, the preferential treatment for foreign companies will come to an end, as Chinese lawmakers approaved a single corporate tax rate of 25%. Yet, a five-year phase-in period and continued tax privileges for high-tech and other high-priority industries, will smoothen the transition process.

[2]Aitken and Harrison (1999), Konings (2001), Javorcik (2004), Takii (2005), Liu (2006).

[3]Caves (1974), Globerman (1979), Blomström, Globerman and Kokko (2000), Haskel, Pereira and Slaughter (2002), Branstetter (2006).

[4]Following recent empirical work by Javorcik and Spatareanu (2006) and Liu (2006).

market forces. Instead they continue performing the dual tasks of producing goods and providing social welfare. The Chinese central government tends to use these firms as policy tools in their aim for social stability, and only gradually confers SOEs the formal right to make independent input decisions according to their production needs (Bai *et al.* 2000). Based on this information we decided to exclude the SOEs from our analysis.[5]

Our main findings are, first of all, that domestic firms engaged in a joint-venture with a foreign partner are on average more productive, as well as exporting plants and plants located in special economic zones. In addition we find on average positive spillovers from FDI on domestic firms, i.e. there is evidence that domestic firms benefit from the presence of foreign investors located in the same sector. Exporters suffer from foreign competition, yet this largely reflects a decrease in their markups, rather than lower productivity. Moreover, the structure and origin of ownership matter for spillovers, in the sense that Sino-foreign joint ventures are more likely to generate a positive impact on the local market than wholly foreign owned enterprises. FDI originating from overseas Chinese, on the one hand, increases the average productivity level in the domestic market, but on the other hand, given their focus on processing trade, the competition effect on domestic exporters is more severe. Finally, various robustness checks stress the importance of studying the heterogeneity within a group of firms when analyzing policy questions.

The rest of this paper is organized as follows. In the next section we review the theoretical background on spillovers. Section 3 provides some facts on FDI in China, while Section 4 presents the data used in our empirical analysis. Section 5 gives the econometric model that we seek to estimate. Section 6 reports and discusses the results, Section 7 is a concluding one.

2 Spillovers 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 plant'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 the affiliate of the multinational, but spill over to other firms operating in the same region or sector (horizontal spillovers). From the literature we can identify four positive spillover channels: demonstration and imitation spillovers

[5]The collective owned enterprises used to be state controlled, but since the beginning of the nineties the collectives have been transformed into private firms. Nowadays, these firms can be considered as fully private. We thank Barry Naughton for pointing this out.

(related to products and technology, export, and managerial skills), acquisition of human capital (through training and inter-firm mobility), competition effects (reduction in X-inefficiencies and reduction of market distortions), and the hardening of soft budget constraints. Foreign firms may also stimulate production in upstream or downstream activities through increased demand for intermediate products and higher quality requirements (vertical spillovers). Conversely, 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 plants - 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.

When we look at the channels through which export spillovers can occur, we notice that there are several (opposite) forces at work. Exports can, on one hand, be considered as an example of demonstration spillovers. Typically multinational corporations 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 exporters may learn how to improve their performance in foreign markets. In addition they may benefit from increased market access achieved by the foreign company, such as infrastructure, trade organizations or reductions in trade barriers.

Besides, it has been extensively documented in the literature that exporting firms are more productive than average firms (e.g. Bernard and Jensen, 1999). This higher initial productivity reflects in the first place a self-selection effect related to the additional costs that firms face when selling in foreign markets. These sunk costs can take the form of market research, expenses related to the establishment of distribution channels, or production costs to modify products to foreign tastes. Once firms have reach the threshold productivity level and enter the export market, they are exposed to fierce competition in the export market. Given the requirements of specific managerial and technical skills related to exports and the resulting higher initial productivity, there is less scope left for these firms to learn from incoming foreign investment. In other words, the expected positive spillover effects are limited for exporters.

Finally, increased competition for input factors and market share drives firms up their average cost curves, which then results in a lower productivity (Aitken and Harrison, 1999). When foreign firms relocate their production facilities to the host country, for instance China, to take advantage of the same cheap inputs, the host country will experience an upward pressure on the cost of inputs. Firms producing in the same sector are more likely to utilize similar inputs, or hire workers qualified in the same specialisation field. An increase in production costs, will lead to lower measured productivity when inputs in the production function are measured in cost of inputs rather than in units of input. An example of this competition effect is labor hoarding. Lipsey and Sjoholm (2004) provide evidence that multinationals tend to pay more for labour of a given quality than local firms. This wage gap will displace domestic competitors, who in turn, forced to either pay higher wages as well or hire less productive workers. In both cases the labour hoarding effect results in a negative externality in the local economy.

In sum, the above discussed channels through which FDI can affect exporting firms generate opposite forces, and depending on which dominate the net externality will be either positive or negative.

An additional determinant of the magnitude of FDI induced spillovers that has been proposed by the literature is the degree of ownership.[6] 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.[7] The 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.[8] On that account less 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.

[6] Only few studies have paid attention to impact of ownership structure on FDI spillovers: Blomström and Sjöholm (1999), Dimelis and Louri (2001), Takii (2005) and Javorcik and Spatareanu (2006). For a theoretical discussion see Muller and Schnitzer (2006).

[7] 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 certain sectors, i.e. in the Chinese banking sector the share of foreign capital is not allowed to be bigger than 25%. Following China's WTO accession agreement, foreign banks are able to offer loans or banking services directly to Chinese citizens only since 2007.

[8] See Ramachandran (1993)

Finally, we observe a different pattern of foreign investment according to its country of origin. While companies from industrialized countries usually invest in the more technologically advanced sectors, such as electronics, machinery, medicines, and automobiles, overseas Chinese in Hong Kong, Macau and Taiwan tend to relocate relatively simple, labor-intensive activities, like garments, footwear, and light electronics to China (Zhang, 2005). Not only the degree of technological sophistication, but also the underlying motives and production structure of FDI varies with the origin. The main motivation of Western investors has been the desire for access to local markets rather than the search for low-cost labor for assembling. Western investors prefer either equity joint venture, or wholly foreign-owned enterprises due in large part to the strong interest in developing long-term projects aimed at the Chinese domestic market. Conversely, contractual joint venture has been particularly appealing to HMT projects that tend to be relatively small and short in duration, focusing on export-processing products. We investigate whether the origin matters for the generation of spillovers to local firms.

3 Foreign investment and business 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. These development zones were not only 'special' in the sense that they offer special tax incentives for foreign investments, but they were also granted more autonomy over their economic policies and institutional environment than the rest of the country. 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 2005. 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.[9]

[Figure 1: Foreign Direct Investment inflows in China (1991-2005)]

As discussed in the previous section, 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. 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.

4 Data and summary statistics

The data used in this paper are drawn from the Oriana CD-ROM (version January 2007) 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 23,613 plants over the period 2002 and 2004.[10] We restrict our attention to the manufacturing sector, based on the US SIC 1987 classification (sectors 20-39). The number of observations is reduced to 14,024 plants (as an average over the three year period) due to missing values on some of the input factors (see Appendix A for a detailed description of the dataset and cleaning process).

Table 1 reports summary statistics for the basic variables employed in this paper, pooled over different groups. Sales and value added are deflated by a provincial producers' price index of industrial products. Capital is deflated by a provincial price index

[9] China Statistical Yearbook 2000

[10] A comparison of our data with the China Economic Census Yearbook 2004 reveals that the Oriana data covers 52% of total manufacturing sales of medium-size and large-size enterprises in China. Remark however that the Census reports information for fims with annual sales above 5 million RMB, a threshold considerably lower than the one applied by Bureau Van Dijk.

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. When the size of a plant is measured by its sales, foreign plants are 50% larger than their domestic counterparts. Yet, domestic plants employ on average more workers than their foreign counterparts. The descriptive statistics reveal that foreign plants are not only larger relative to domestic plants in terms of sales and value added, but they are also more capital intensive, invest more per worker, and enjoy higher productivity. The disparity is even more pronounced when we only consider companies from countries other than Hong Kong, Macau and Taiwan. These differences may result from a selection bias, which reflects the tendency of foreign plants to acquire more productive local plants or to invest in higher productive sectors and regions. When splitting up the group of foreign firms by degree of ownership we notice that the difference between sino-foreign JVs and WFOEs is rather small. Only the capital intensity is substantially larger in JVs, which also leads to a higher labor productivity.

[Table 1: Summary statistics for manufacturing plants in China]

In Table 2 we compare exporting versus non-exporting firms, both for the whole sample as for domestic firms separately. On the one hand, domestic firms that are not engaged in exporting are larger relative to non-exporters in terms of number of employees, sales and value added. Yet, when comparing the ratios per worker, we notice that - contrary to the stylized fact found in the literature - Chinese exporting domestic firms are less capital intensive, invest less per worker, are less productive, and have less sales and value added per worker. This is not only the case for domestic firms, but the same pattern is found for the entire dataset. This finding could be partically explained by the fact that most exporters are located in labor intensive sectors, but we will come back to this issue in section 6 when discussing our results.

[Table 2: Summary statistics for exporting versus non-exporting plants]

An overview of the sectoral and regional distribution of foreign plants in our dataset is given in Appendix B en C. More than 90% of all foreign capital in China 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 central 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.[11] Only

[11] An comprehensive overview of the various types of the China Development Zones is provided by the China Association of Development Zones (http://www.cadz.org.cn/en/).

since the beginning of the nineties China gradually started to target its inland. The southern coastal provinces benefit additionally from the geographical and cultural proximity to the overseas Chinese communities in Hong Kong, Macao, and Taiwan. 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 C 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.[12] While the textile processing industry continues to attract a lot of FDI, the investment focus broadened to more technically advanced sectors such as chemicals, and mechanical and electronics industries. This shifting sectoral composition partly 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. When labor costs started rising at home, these overseas investors were mainly 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 companies from industrialized countries, interested in serving the huge domestic market through local production. The final column shows the foreign pressence in a sector, as defined by the share of foreign sales in total sales at the 3-digit US SIC industry-level. On average, foreign sales represent 48% of total sales of large- and medium-size firms in the Chinese manufacturing.[13]

5 Econometric Approach

We follow the recent productivity literature,[14] and start from a general Cobb-Douglas production function,

$$Y_{it} = A_{it} F_i \left(L_{it}^{\beta_l} M_{it}^{\beta_m} K_{it}^{\beta_k} \right), \tag{1}$$

where i and t indicate plant and time respectively. Y stands for output, while L, K and M represent the inputs used in production, being labor, physical capital stock and materials respectively. The β's are the factor shares of the different production inputs. The index A_{it} is a measure of technical efficiency or Total Factor Productivity (TFP) of

[12] China Statistical Yearbook 2005

[13] This figure is a realistic representation compared to the data from the China Industrial Economic Census, where foreign sales count for 53% of total sales of large- and medium-size enterprises (excluding SOEs, since these are excluded in our analysis).

[14] Olley and Pakes (1996), Klette and Griliches (1996), Levinsohn and Petrin (2003), Melitz (2000) and De Loecker (2007).

plant i at time t. We assume TFP to be determined by foreign participation and various spillover effects, and control for sector-, city-, and time-specific determinants of technical efficiency:

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

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 are usually not limited to the receiving affiliate of the multinational, but are likely to spill over to firms that come in contact with the multinational. To analyze the direct and indirect effects of inward foreign investment, the main purpose of this paper, we proceed in two steps. In section 5.1 we estimate the log-linear transformation of the Cobb-Douglas production function in equation (1), to obtain plant-specific TFP levels. These productivity estimates are then related in section 5.2 to the foreign presence in a particular sector.

5.1 Productivity estimation

Consider

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_m m_{it} + \beta_k k_{it} + e_{it}, \tag{3}$$

where the small letters stand for the natural logarithms of the respective variables and the β's represent the elasticity of output with respect to the inputs. Output y_{it} is measured as sales deflated by a provincial ex-factory price index of industrial products. The number of employees in each plant are used in the estimation for the labor input l_{it}, while materials m_{it} are calculated as total costs of the goods sold minus the cost of employees, deflated by the provincial ex-factory price index of industrial products. Capital k_{it} represents the tangible fixed assets of a plant which are deflated by a provincial price index of investment in fixed assets. This price index takes into account the actual purchasing prices or balancing prices of investment in fixed assets. All price indices used in our analysis are taken from various editions of China Statistical Yearbook.

The estimation of equation (3) using ordinary least squares (OLS) suffers from an endogeneity bias, which stems from the correlation between unobserved productivity and a plant's input decisions. If more productive plants tend to hire more workers and buy more materials due to higher current and anticipated future profitability, OLS will tend to provide upwardly biased estimates on the input coefficients. In order to control for both biases, Olley and Pakes (1996 - OP hereafter) suggest a methodology using capital and investment as a proxy for productivity. A detailed description of the semi-parametric approach of OP can be found in Appendix D.

A productivity measure based on the real value of output might not reflect the firms' productivity ranking if they charge different markups. If firms have some price setting power the estimates of the β's will still be biased, since inputs are likely to be correlated with the price a firm charges. Ideally one would use physical output or sales deflated with firm-level price information to estimate our production function. Since this information is not available we have to deflate sales using provincial price indices. This is however only valid if firms all face the same price and have no pricing power. In an imperfectly competitive environment output prices will differ among firms, and the firm-level price deviations from the provincial price index end up in the error term $(e_{it} + p_{it} - p_{It})$, hereby causing an omitted price variable bias in our estimations. To control for this bias we follow the approach suggested by Levinsohn and Melitz (2002) and De Loecker (2007), and introduce a demand system to correct the productivity estimates for demand shocks. De Loecker's (DL hereafter) approach is based on Levinsohn and Melitz (2002) who elaborated the framework of Klette and Griliches (1996) in estimating TFP. While DL allows in his paper for firms that produce multiple products, data constraints oblige us to neglect this issue in our study. DL's methology is explained in detail in Appendix E.

Other work by Katayama, Lu and Tybout (2005) stresses that also variation in factor prices and heterogenous factor stocks might affect the productivity measures. Data limitations constrain us from controlling for these biases, yet we allow the production function coefficients to differ between domestic plants, and JVs. As pointed out by several studies there are essential differences between characteristics of foreign and domestic firms.[15] Moreover, foreign firms in China tend to import an important part of their components and materials used in their production (OECD, 2000). Hence, it is be important for our study to make a distinction between the different groups.

Controlling for the simultaneity bias and the omitted price variable bias is of particular importance in this study, since the TFP measure is simply the regression residual and therefore crucially dependent on the goodness of fit of the model. The estimated input coefficients of the Cobb-Douglas production function for domestic firms are listed by sector in Appendix F.1 and F.2. Equation (3) is estimated using the three different approaches that are discussed above: OLS (column 1 and 2), controlling for the simultaneity bias (Olley-Pakes, column 3 and 4), and finally correcting in addition for the omitted price bias (De Loecker, column 5 and 6). To allow for differences in technologies the coefficients are not only permitted to vary both across sectors, they are also estimated separately for purely domestic firms and joint-ventures. The estimates are statistically significant for most of the twenty different sectors. As expected, OLS typically over-estimates the labor coefficient, while the impact on the coefficients of material and capital is less clear-cut. According to the theory the simultaneity problem should bias the capital coefficients up-

[15] For example Markusen (2002) and Tybout (2000).

wards, whereas the selection bias should generate a downward bias in the OLS estimates. Since we are not able to control for the selection bias due to data constraints, the estimates for all of the three approaches are still likely to be biased downward. Though, the correction for the simultaneity bias clearly shows up in a lower capital coefficient for OP compared to OLS. In the third column we additionally control for the omitted price bias. In accordance with the arguments put forward by Klette and Griliches (1996), the use of deflated sales as a proxy for real revenu tends to underestimate the coefficients of OLS and OP compared to DL for some sectors. On average, however, the omitted price bias does not seem to affect the coefficients significantly. A closer look at the output coefficients for each of the sectors separately reveals that for most of the sectors the output estimate is indeed statistically insignificant, reflecting a very elastic demand in the Chinese manufacturing sector (Appendix F.3). Yet, for those few sectors with a markup that is signicifantly different from zero, it is important to control for the market power.

To recover the productivity estimates, TFP is calculated in the standard way:

$$\ln TFP_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_k k_{it}, \tag{4}$$

where $\hat{\beta}_h$ (with $h = l, m, k$) stands for the estimators of the respective inputs using the different approaches that are discussed above. The TFP estimates using the different methodologies are presented in Appendix F.4. Joint-ventures are on average more productive in most sectors, while the columns of the standard deviation show a bigger heterogeneity in the productivity level of joint-ventures for a majority of the sectors in the Chinese manufacturing industry. To visualize the impact of the different methodologies, the kernel densities for two different sectors are plotted in Appendix F.5. For the first sector "Apparel and other textile products" the three approaches generate very similar distributions in productivity levels both for domestic plants and JVs. Given that we are mainly interested in the distribution of TFP rather than the precise production coefficients, it is encouraging that the productivity distributions across the different applied methodologies are very alike. Yet, when we have a look at the TFP distribution for sector "Chemicals and allied products", sector (domestic plants) and sector "Primary metal industries" (joint-ventures) we have a different story. Remember from Appendix F.3 that the pricing power in these sectors is substantial. As discussed above, the existence of markups biases our TFP estimations, and leads to a different distribution in the plant-level productivity. For the discussion of our results in Section 6 we will therefore take this into account and discuss the implications.

5.2 Productivity spillovers

With the TFP estimates for hand we are now able to turn to the key purpose of this paper, namely the estimation of the impact of foreign direct investment on the productivity of domestic firms. We check whether the positive 'learning' effect dominates the negative competition effect generated by foreign firms. Using the results of the previous section, we relate the estimated plant-level TFP measures to the foreign presence in a particular sector to analyze the direct and indirect effects of FDI at the plant level. More specifically, we estimate:

$$\ln TFP_{it} = \alpha_1 JV_i + \beta_1 Spillover_{jt} + d_j + d_c + d_t + \eta_{it}, \tag{5}$$

which allows us to analyze the various factors that affect the technical efficiency of a plant. The model is estimated on a sample of domestic firms only to single out the effect on other foreign firms and to obtain a cleaner picture of the impact of inward FDI on the performance of Chinese manufacturing firms. We define JV_i as a dummy variable being equal to one when a plant engages in a joint-venture.[16] Following the observations in Appendix F.4 where JVs have on average a higher productivity level, we expect a positive coefficient α_1. Unfortunately, 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 2006). These data limitations prevent us from controling for the cherry-picking behaviour of foreign investors. However, by including sectoral and provincial dummies we capture the main elements of this potential selection bias.

The effects of foreign investment are in general not restricted to the receiving foreign affiliate, but may influence the productivity of other firms in the same sector through a variety of channels as discussed in section 2. To evaluate the indirect efficiency impact of total inward foreign investment at the sector level, the regression is extended by the variable $Spillover_{jt}$. $Spillover_{jt}$ is a measure for the presence of both JVs and WFOEs in the same sector and is defined as the share of foreign sales in total sales at the 3-digit US SIC industry-level.[17] This variable measures the impact of foreign firms on the domestic market, i.e. either a negative competition effect or a positive imitation effect. Depending on whether or not the negative competition effect related to foreign investment dominates the positive learning effect, $\beta_1$will be either negative or positive. Finally, the dummy variables d_j, d_c and d_t are added to take into account unobserved industry-, city-, or time varying factors. This allows us to control partly for the endogeneity problem that

[16] A firm is considered foreign when the legal form is defined as either "China & Foreign Cooperation Management", "China & Foreign Joint Venture Management", "Foreign Investment Share Holding", "Cooperative Management (Hongkong, Macao and Taiwan)", "Investment Share Holding (Hongkong, Macao and Taiwan)", "Joint Venture Management (Hongkong, Macao and Taiwan)".

[17] In this study we concentrate on horizontal spillovers and do not touch upon vertical spillovers as in e.g. Smarzynska (2004). For an analysis of the FDI linkage effects to backward and forward sectors in the Chinese manufacturing sector, we refer to Liu (2006).

the more productive firms, sectors or provinces might attract more foreign capital.[18] We correct for heteroskedasticity and cluster the standard errors at the plant level to take into account potential correlation.

The variable $Spillover_{jt}$ measures the impact of foreign firms on the domestic market. Yet, as discussed in section 2 there may be different forces at work (or with a different magnitude), for plants that are engaged in exporting compared to their non-exporting counterparts. A majority of foreign firms regard China as an inexpensive production base, and especially investment originating from overseas Chinese in Hong Kong, Macau and Taiwan is mainly export-driven (Whalley and Xin, 2006). Given this fact the export channel might be an import channel through which foreign investment affects the domestic firms. We construct an additional dummy variable, $Exporter_{it}$, which takes the value of one if the plant is exporting at time t. Additionally, we extend equation 5 with the interaction between $Spillover_{jt}$ and $Exporter_{it}$:

$$\ln TFP_{it} = \alpha_1 JV_i + \alpha_2 Exporter_{it} + \beta_1 Spillover_{jt} + \beta_2 Spillover_{jt} \times Exporter_{it} + d_j + d_c + d_t + \eta_{it}. \quad (6)$$

Special Economic Zones (SEZs) are constructed by the Chinese government with the main purpose to promote spillovers from foreign establishments to the domestic economy (see section 3), and therefore a perfect case for our analysis. In particular we want to examine whether the spillovers are solely attributable to these zones, or whether they occur in the whole economy. In order to do so we construct a new dummy variable SEZ_i which takes the value of one when plant i is located in a city in which a development zone is established.[19] The dummy is constructed on the basis of a list provided by the China Association of Development Zones. We include this dummy in our regression to control for a potential higher productivity level in these zones due to special benefits that are not granted to firms outside the zones. In addition we interact the dummy with our spillover measure $Spillover_{jt} \times SEZ_i$ to investigate whether or not efficiency spillovers are more likely to occur within these zones.

$$\ln TFP_{it} = \alpha_1 JV_i + \alpha_2 Exporter_{it} + \alpha_3 SEZ_i + \beta_1 Spillover_{jt} + \beta_2 Spillover_{jt} \times Exporter_{it} + \beta_3 Spillover_{jt} \times SEZ_i + d_j + d_c + d_t + \eta_{it}. \quad (7)$$

A final contribution of this study is the analysis of the impact of the ownership structure on the magnitude of spillovers. To analyze this question into further detail, we

[18] 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).

[19] Unfortunately we do not know the exact location of the plant within a city, meaning that we cannot distinguish whether the firm is located in the zone, or in the surrounding area in the same city.

differentiate in our final regression between Sino-foreign joint-ventures (JVs) and Wholly Foreign Owned Enterprises (WFOEs):

$$\ln TFP_{it} = \alpha_1 JV_i + \alpha_2 Exporter_{it} + \alpha_3 SEZ_i + \beta_1 Spillover\_JV_{jt} \quad (8)$$
$$\beta_2 Spillover\_WFOE_{jt} + d_j + d_c + d_t + \eta_{it}. \quad (9)$$

The reason behind this distinction relates to the expected difference in spillovers related to WFOEs versus JVs, as discussed in section 2. The more a multinational controls the establishment, the greater its ability to protect its technology from spilling over to other plants. Since these firms are less afraid to use their latest technological innovations, they are more likely to outperform local producers. We therefore presume that the competition effect will be fiercer in the case of WFOEs, while the imitation spillovers might dominate for JVs.

6 Results

6.1 Sectoral spillovers

Table 3 shows the baseline results for the FDI induced sectoral spillovers, with the dependent variable $\ln TFP_{it}$ calculated according the Olley-Pakes methodology. First of all, our results illustrate a significant difference in the performance of domestic plants and JVs, with the magnitude slightly differing with the specification. The positive and statistically significant coefficients on the joint-venture dummy JV_i reveal that after controlling for firm-specific aspects, JVs produce with the same inputs about 17 to 18% more output than their domestic counterparts. This finding might however be due to the fact that foreign firms tend to engage in a JV with the better performing domestic plants or locate in more productive sectors and regions. Data constraints on the change in ownership do not allow us to draw conclusions about the causality of the higher productivity. When we have a look at the indirect effect of foreign investment we find some small but statistically significant spillover effects. On average firms in the Chinese manufacturing sector seem to benefit from the presence of multinationals in their sector. In a sector where the presence of foreign firms, as measured by the share of foreign sales, is 10 percentage points higher than the average, domestic plants are about 0.4 to 1.9 percent points more productive, ceteris paribus. With an average of 48 percent foreign sales in total sectoral sales in the Chinese manufacturing industry, the average measured productivity is about 1.92 to 9.12 percent higher than would have been without the inflow of foreign capital.

[Table 3: Sectoral spillovers in the Chinese manufacturing sector]

In the second column of Table 3 we allow the spillovers to vary between exporting versus non-exporting firms by including the export dummy $Exporter_{it}$ and the interaction term $Spillover_{jt} \times Exporter_{it}$ in the regression. In the first place we find that plants engaged in exporting are slightly more productive than their non-exporting counterparts. Remember that the summary statistics in section 4 indicated that labor productivity was lower for exporting plants. However, the positive and significant coefficient on $Exporter_{it}$ tells us that once we control for the capital intensity of a plant the measured total factor productivity is somewhat higher for exporters than for non–exporters. This result is consistent with the stylized finding in the literature. Yet, regardless their higher productivity export-oriented plants seem to suffer from the presence of foreign firms in their sector. The negative coefficient on $Spillover_{jt} \times Exporter_{it}$ offsets the positive average spillover effect.[20] In section 2 we summarized the various positive and negative effects of foreign investment for exporting firms. Our results indicate that the competition effect seems to outperform the knowledge spillover effect. This indicates that the scope to learn from incoming FDI is indeed rather limited for those firms that are exporting and already possess the necesary skills to compete in the world market. For domestic firms this positive externality is more likely to offset the negative competition effect in the factor markets. The labor hoarding effect might be particularly important in the case of exporting firms since they need highly qualified technical and management personnel to survive in the export market.

The existence of Special Economic Zones (SEZs) is a special feature of the Chinese foreign policy and a third source of consideration in our analysis. In column 3 we add a dummy variable for SEZs (SEZ_i) and interact this dummy with our spillover measure $Spillover_{jt} \times SEZ_i$. Although firms located in a SEZ are on average more productive than other plants, they do not seem to react in a different way to the presence of foreign firms than the average Chinese firm. Yet, when we split up the group of economic zones into different varieties,[21] we notice that one zone in particular seems to generate the desired benefit from foreign investment, namely National Economic and Technological Development Zone (ETDZ). This finding justifies partly the major efforts of the Chinese government to create an pro-active environment in which the collaboration with foreign firms is more likely to generate the expected beneficial effects. Nevertheless, it gives as well food for thought about the specific characteristics that should be in place for spillovers to occur. Zones as National Free Trade Zones (FTZ), National Export Processing Zones

[20] We must be careful not to look separately at the t-statistic of the coefficient estimates on $Spillover_{jt}$ and $Spillover_{jt} \times Exporter_{jt}$ 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 43.93, so we are able to reject the null hypothesis at the 10% level.

[21] The China Association of Development Zones lists 6 types of SEZs: National Economic and Technological Development Zone (ETDZ), National Free Trade Zone (FTZ), National Hi-Tech Industrial Development Zone (HIDZ), National Border and Economic Cooperation Zone (BECZ), National Export Processing Zone (EPZ), and National Tourist and Holiday Resort (THR). In our analysis we exclude, however, the last type of SEZ, since technological spillovers are not the underlying reason for the establishment of this zone.

(EPZ), and National Border and Economic Cooperation Zones (BECZ), are established mainly to develop trade and carry out processing for re-export. On the other hand, ETDZs and National Hi-Tech Industrial Development Zones (HIDZ), are created to attract foreign capital and technology to fasten the development of China's own high tech industries. These results are consistent with our finding of negative spillovers through export, and show that the attraction of export-driven investment is not necessary a beneficial strategy for generating positive externalities on the domestic market.

[Table 4: Sectoral spillovers using different methodologies]

In Table 4 we re-estimate equation (7) using three different methodologies to check the sensitivity of our results to the chosen Olley-Pakes approach in Table 3. In the first column the dependent variable is the logarithm of labor productivity[22], while in column 2 and column 3 TFP is calculated using respectively an OLS estimation of the Cobb-Douglas production function, and Olley-Pakes' methodology to control for the simultaneity bias. Overall, the three approaches display very similar results, with only the magnitude of the effects differing slightly. Across all approaches there is evidence of positive FDI spillovers on average in the Chinese manufacturing industry, while the impact on exporting firms in particular is negative and only some of the SEZs generate the expected positive spillovers. In accordance with the summary statistics presented in section 4 the coefficient on $Exporter_{it}$ becomes negative when looking at the FDI induced spillovers on labor productivity (Column 1 and 4). To avoid an abundance of results and to maintain a clear overview, we will discuss from now on only the results of the Olley-Pakes specification. This should not be a restriction however, since we just showed that spillover effects are consistent over the different approaches.

6.2 Spillovers and the role of ownership structure

We now analyze in more detail the role of ownership structure in generating spillovers to local firms. In Table 5 we distinguish between investment made through a joint venture with a local firm versus wholly foreign owned enterprises. The type of foreign investment clearly influences the impact on the local market. More specifically, the basic specification in Column 1 displays that the positive spillovers are generated entirely through the presence of JVs. A 10 percentage points higher share of JVs in an industry boosts the production of domestic plants with about 1.9 percentage points. These findings confirm our expectations that due to the specific nature of a JV, information and technology tends to leak out much more easily than in the case of WFOEs. A local firm can learn from the experience of a foreign firms, for example by using the same technology in their own firm or through the mobility of workers. On the other hand, the negative impact of the

[22] In the labor-productivity specification we additionally control for the capital intensity of a plant when running the regressions.

presence of WFOEs is probably the result of the use of more advanced technology used in the production, combined with a better protection of their know-how.

[Table 5: Spillovers and the role of ownership structure]

When we dig deeper into the impact on various subgroups in Column 2, we see that WFOEs mainly compete with local firms within a SEZ or with those firms that are engaged in exporting. The average spillover from WFOEs now becomes positive. Another very interesting finding is the negative coefficient on $Spillover\_JV_{jt} \times Exporter_{it}$. Given that exporters are already more productive than the average firm, the scope to learn from foreign firms is smaller. Hence the leakage of information is of less importance for this group, so the presence of both JVs and WFOEs has a similar effect on exporters. This result provides evidence that the leaking of technology is likely to be the driver of the major difference in spillovers originating from both ownership structures.

6.3 Impact according to the origin of FDI

In the introduction and the data section we pictured the different characteristics of investment coming from overseas Chinese versus western investment. Since we expect these differences to have an impact on the spillover effects they engender, we divide FDI in our sample in two groups: investment originating from Hong Kong, Macau and Taiwan (HMT hereafter) versus the rest (non-HMT).[23] The latter group mainly consists of FDI coming from technologically advanced countries, such as Europe, Canada or the United States. We include a regional dummy to check whether both groups differ in productivity, and run regression (7) twice: once with the variable $Spillover_{jt}$ representing the share of HMT sales in total sales at the 3-digit US SIC industry-level, and a second time with the share of non-HMT sales. The results are represented in Table 6.

[Table 6: Spillovers according to the region of origin]

We retain three new insights from this exercise. First of all, there is a clear difference in measured productive efficiency of HMT companies versus the non-HMT group. While HMT firms are in general only slightly more productive than domestic manufacturing firms, non-HMT companies derive their advantages from leading-edge technological know-how and efficient marketing networks. This is in accordance with the summary statistics presented in Table 1. Secondly, there are positive spillover effects associated with the presence of both groups of foreign investors, yet the coefficient on $Spillover_{jt}$ is bigger for HMT investment compared to non-HMT investment. This most probably results from the cultural and linguistic connection of overseas Chinese with Mainland China which

[23] Investment coming from tax havens such as British Virgin Islands, Bermuda and Cayman Islands, is generally considered as diverted investment from HMT or China itself for tax evasion (Naughton, 2007). We therefore included these countries along HMT in our analysis.

facilitates the negotiation and cooperation with Chinese entrepreneurs and promotes the diffusion of technological know-how. Besides, the relatively high capital intensity, and advanced and complex technology utilized in the production of industrialized countries' companies make it more difficult for Chinese firms to imitate their production. Thirdly, the negative impact on domestic exporting firms is fiercer in the case of HMT investment than non-HMT investment. This can be explained by the specific characteristics and underlying motives of HMT investment. For instance, Hong Kong's role as an export entrepôt between China and the rest of the world, urged HK firms to relocate their labor-intensive activities to Mainland China when labor costs started rising at home. As such, HMT investors regard China as an inexpensive production base and their investment is mainly export-driven. This then surfaces in a more pronounced negative impact on export-oriented firms.

6.4 Robustness checks

To substantiate our findings of the baseline specification, we perform in this section a number of robustness checks. The results for these additional regressions can be found in Table 7. In the first column the results of the original regression using the Olley-Pakes methodology (see Table 3) are displayed to allow comparison over the different specifications. First, we perform the analysis again, but with an alternative measure for the presence of foreign firms. This allows us to verify whether the obtained results are driven by the choice of our spillover variable. Instead of computing $Spillover_{jt}$ with sales, we define $Spillover_{jt}$ now as the share of foreign employment in total number of employees at the 3-digit US SIC industry-level. This spillover measure has been used in the literature together with our original computation. This alternative specification does not only allow us to check the robustness of our results, but also broaches a specific spillover channel, namely the acquisition and mobility of 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. Imitation spillovers may also take place with regard to managerial and organizational practices. As shown in Column 2 of Table 7, overall our original findings are confirmed, only the magnitude of the coefficients increases slightly for all coefficients. Yet, this difference in magnitude reveals some interesting points. The higher coefficient on $Spillover_{jt}$ indicates that the diffusion of technological know-how is more likely to occur through the acquisition of human capital and labor mobility rather than through sales. Employees trained in multinationals may use their acquired knowledge to set up their own firms or apply the practices in other companies. On the other hand, the bigger negative impact on exporting firms and firms located in SEZs fortifies our previous argument that foreign fims are able to attract highly qualified technical and management personnel, and divert the best workers away from domestic firms.

[Table 7: Robustness checks]

Given the extensiveness of the Chinese country, it seems unlikely that a company located in the southern province Guangdong can learn from a multinational located in Beijing, whether or not they produce similar goods. Since spillovers are more likely to occur at the local level, we broaden the analysis and use the presence of foreign companies at the regional level. Given that the 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. $Spillover_{jt}$ therefore denotes the share of a city's sales produced by foreign firms. We can see from the results of this regression given in the third column of Table 7, that firms indeed benefit from foreign investors located nearby. In cities with a 10 percentage point bigger share of foreign sales, domestic firms will be on average 1.7 percent points more productive. The difference with the sectoral spillovers in Column 1 is however marginal, indicating that spillovers occur both at the sectoral and regional level, and to more or less the same extent.

A final robustness check considers the existing market structure, and more specifically the level of competition in the sector. As a measure for the amount of competition among firms in a particular sector we calculate the Herfindahl-Hirschman Index (HHI), which is defined as the sum of the squares of the market shares of each individual firm. The index is calculated at the 3-digit US SIC level and can range from 0 to 1 moving from a very large amount of very small firms to a single monopolistic producer (Table 8). With the competition measure for hand, we now exploit the sectoral differences to analyze whether the ex ante degree of competition influences the extent to which spillovers actually take place. We include the competition measure on itself, as well as in interaction with the spillover measure $Spillover_{jt} \times HHI_{it}$. Our results tell us that in a sector with less competition firms are considerably more productive on average. In these sectors, on the other hand, spillovers are less likely to occur. Related to this issue of competition is the methodology of De Loecker to estimate productivity. His framework allows us to control for the market power of firms when estimating TFP. By doing so we correct for the bias caused by imperfect competition in the output markets, and the related markups earned by firms. For example, in the presence of imperfect competition an increase in TFP due to the inflow of foreign capital might also capture changes in the mark-up (through changes in the demand elasticity). Therefore, in the final column we present the results with the dependent variable being the logarithm of TFP calculated according the De Loecker methodology to control for the demand side of the output market. We see that the productivity level of joint ventures compared to domestic firms is somewhat lower once we control for market power. Also the spillover effect from foreign investment is lower, but still significant. Moreover, the negative coefficient on $Spillover_{jt} \times Exporter_{it}$ now becomes insignificant. This confirms our previous inferences that exporting firms suffer from increased pressure in the factor markets due to the presence of foreign companies, but this results in lower markups rather than a lower productivity level in itself. Fierce competition in the export market prevents the exporters to increase their prices when their production costs go up, which reduces their profit margin.

[Table 8: Herfindahl-Hirschman Index]

7 Conclusion

In this paper we used a rich panel dataset of firms producing in China to analyze in detail the impact of inward foreign investment on the performance of Chinese manufacturing plants. The Chinese central government puts into place all kinds of mechanisms to increase the likelihood of positive spillovers on domestic firms. Measures such as the exemption from value-added tax on technology transfer for foreign enterprises encourage technological renovation. In addition it is written in the law on WFOEs that the establishment of foreign-funded enterprises should benefit the development of China's national economy in the sense that enterprises must either adopt international advanced technologies and facilities or export most or all products. In this paper we tried to provide an answer to the question whether these policies have indeed paid off, and whether the results justify the costs such as forgone taxes. We did not restrict ourselves to analyzing the aggregate (or net) effect of foreign presence, but devoted most effort to investigating the heterogeneity within the Chinese manufacturing industry. In particular, we looked at conditions favouring or hindering foreign investment spillovers, such as economic zones, origin of FDI, exports, and ownership structure.

Our results reveal in the first place significant differences in the performance of purely domestic firms and those that engaged in a joint-venture with a foreign partner, whereby JVs are clearly more productive than their domestic private counterparts. Also, exporting firms and plants located in special economic zones are on average significantly more productive. The baseline result of our spillover analysis is that there are on average positive spillovers on Chinese local firms. Yet, for exporters the competition effect turns out to more severe than for non-exporters and results in a negative spillover effect. Nevertheless, we want to stress the fact that the robustness checks in final section revealed that the competition effects is more likely to end in a lower markup rather than a lower measured productivity level in se.

In line with the purpose of special economic zones, we do find the expected positive spillovers from foreign investment. Yet, this outcome stays limited to one type of zones in particular, i.e. National Economic and Technological Development Zones (ETDZs).

Another result that should be highlighted is that technological know-how is more likely to leak out from Sino-foreign JVs than from plants over which a multinational has fully control. Moreover, this study made clear that the extent to which domestic firms are able to absorb the technological knowledge depends in an important way on the origin of FDI. FDI originating from overseas Chinese, on the one hand, has a stronger positive impact on the indigenous productivity level than other foreign investment, but on the other hand, given their focus on processing trade, the competition effect on domestic exporters is more severe. Finally, the robustness checks in the last section stress again the importance of studying the heterogeneity within a group of firms when analyzing policy questions.

References

[1] Aitken, B. and A. Harrison (1999), "Do Domestic Firms Benefit from Foreign Direct Investment? Evidence from Venezuela", *American Economic Review 89(3)*, pp.605-618.

[2] Bai, C., D. Li, Z. Tao, and Y. Wang (2000), "A Multitask Theory of State Enterprise Reform", *Journal of Comparative Economics 28*, pp.716-738.

[3] Bernard, A. and J. Jensen (1999), "Exceptional Exporter Performance: Cause, Effect or Both?", *Journal of International Economics, 47(1)*, pp.1-25.

[4] Blomström, M., S. Globerman, and A. Kokko (2000), "The Determinants of Host Country Spillovers from Foreign Direct Investment", *CEPR Discussion Paper 2350.*

[5] Blomström, M and A. Kokko (1998), "Multinational Corporations and Spillovers", *Journal of Economic Surveys 12(2).*

[6] Blomström, M. and F. Sjöholm (1999), "Technology Transfer and Spillovers: Does Local Participation with Multinationals Matter?", *European Economic Review 43,* pp.915-923.

[7] Branstetter, L. (2006), "Is Foreign Direct Investment a Channel of Knowledge Spillovers? Evidence from Japan's FDI in the United States", *Journal of International Economics 68*, pp.325-344.

[8] Caves, R. (1974), "Multinational Firms, Competition and Productivity in Host-Country Markets", *Economica 41*, pp.176-193.

[9] Cheng, L. and Y. Kwan (2000), "What are the Determinants of the Location of Foreign Direct Investment? The Chinese Experience", *Journal of International Economics 51*, pp.379-400.

[10] De Loecker, J. (2007), "Product Differentiation, Multi-Product Firms and Structural Estimation of Productivity", *NBER Working Paper 13155.*

[11] Dimelis, S. and H. Louri (2001), "Foreign Direct Investment and Efficiency Benefits: a Conditional Quantile Analysis", *CEPR Discussion Paper 2868.*

[12] Findlay, R. (1978), "Relative Backwardness, FDI and the Transfer of Technology", *Quarterly Journal of Economics 92(1)*, pp.1-16.

[13] Glass, A. and K. Saggi (1998), "International Technology Transfer and the Technology Gap", *Journal of Development Economics 55*, pp.396-398.

[14] Globerman, S. (1979), "Foreign Direct Investment and Spillover Efficiency Benefits in Canadian Manufacturing Industries", *Canadian Journal of Economics 12*, pp.42-56.

[15] Haskel, J., S. Pereira and M. Slaughter (2002), "Does Inward Foreign Direct Invest-

ment Boost the Productivity of Domestic Firms?", *CEPR Discussion Paper 3384.*

[16] Javorcik, B. (2004), "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages", *American Economic Review 94(3)*, pp.605–627.

[17] Javorcik, B. and M. Spatareanu (2006), "To Share or not to Share: Does Local Participation Matter for Spillovers from Foreign Direct Investment?", *Journal of Development Economics forthcoming*

[18] Katayama, H., S. Lu and J. Tybout (2005), "Firm-level Productivity Studies: Illusions and a Solution", *mimeo*

[19] Klette, J. and Z. Griliches (1996), "The Inconsistency of Common Scale Estimators When Output Prices are Unobserved and Endogenous", *Journal of Applied Econometrics 11(4)*, pp.343-361.

[20] Konings, J. (2001), "The Effects of Foreign Direct Investment on Domestic Firms", *Economics of Transition 9(3)*, pp.619-633.

[21] Levinsohn, J. and M. Melitz (2002), "Productivity in a Differentiated Products Market Equilibrium", Harvard *mimeo.*

[22] Levinsohn, J. and A. Petrin, "Estimating Production Functions Using Inputs to Control Unobservables", *Review of Economic Studies 70*, pp.317-341.

[23] Lipsey, R. and F. Sjoholm (2004), "Foreign Firms and Indonesian Manufacturing Wages: An Analysis with Panel Data', EIJS working paper, no.166, Stockholm School of Economics.

[24] Liu, Z. (2006), "Foreign Direct Investment and Technology Spillovers: Theory and Evidence", *Journal of Development Economics forthcoming*

[25] Markusen, J. (2002), "*Multinational Firms and the Theory of International Trade*", Cambridge, MA, MIT Press.

[26] Muller, T. and M. Schnitzer (2006), "Technology Transfer and Spillovers in International Joint Ventures", *Journal of International Economics 68*, pp.456-468.

[27] Naughton, B. (2007), "*The Chinese Economy, Transitions and Growth*", Cambridge, MA, MIT Press.

[28] OECD (2000), "Main Determinants and Impacts of Foreign Direct Investment on China's Economy", *OECD Working Papers on International Investment 2000/4 (December).*

[29] Olley, S. and A. Pakes (1996), "The Dynamics of Productivity in the Telecommunications Equipment Industry", *Econometrica 64(6)*, pp.1263-1297.

[30] Ramachandaram, V. (1993), "Technology Transfer, Firm Ownership, and Investment in Human Capital", *Review of Economics and Statistics 75(4)*, pp.664-670.

[31] Sabirianova, K., J. Svejnar, and K. Terrell (2005), "Distance to the Efficiency Frontier and Foreign Direct Investment Spillovers", *Journal of the European Economic Association 3,* pp.576-586.

[32] Takii, S. (2005), "Productivity Spillovers and Characteristics of Foreign Multinational Plants in Indonesian Manufacturing", *Journal of Development Economics 76*, pp.521-542.

[33] Tybout, J. (2000), "Manufacturing Firms in Developing Countries: How Well Do They Do, and Why?", *Journal of Economic Literature 38*, pp.11-44.

[34] Whalley, J. and X. Xin (2006), "China's FDI and Non-FDI -Economies and the Sustainability of Future High Chinese Growth", *NBER Working Paper 12249.*

[35] Zhang, K. (2005), "Why Does so Much FDI from Hong Kong and Taiwan Go to Mainland China?", *China Economic Review 16*, pp.293-307.

A Data description and cleaning process

We use the Oriana database of Bureau Van Dijk (BvD, www.bvdep.com). This is a commercial database of company accounts and includes information of the balance sheets and income statements of medium and large companies in a number of Asian countries. For the purpose of this study, we retrieved detailed information on 23,613 plants for the People's Republic of China. Firm-level data from transition and developing economies often suffer from accounting deficiencies and usually contain missing values and outlier observations that may bias the estimated coefficients. Hence, we carefully clean the original data set to handle the missing observations and outliers, and interpret the results of our study with caution. Nevertheless, this unique firm-level dataset allows us to uncover the heterogeneity among firms in their response to the presence of foreign firms.

Data cleaning:

- We work with unconsolidated accounts only, since we want to restrict our attention to the productivity at a plant's level, and not for the group as a whole. Consolidated accounts are financial statements that factor the holding company's subsidiaries into its aggregated accounting figure. It is a representation of how the holding company is doing, as a group.
- We eliminated the observations that were based on irregular reports or unreasonable data values in the levels of variables (such as negative values for material costs).
- We restrict our attention to the manufacturing sector, based on the US SIC 1987 classification (sectors 20-39).
- To be able to assume profit maximizing behavior we exclude state-owned firms from our analysis.

This leaves us with 12877, 13920, and 15458 observations for the years 2002, 2003 and 2004 respectively.

Variable description:

- Y_{it} =sales of a firm deflated by a provincial producers' price index of industrial products,
- L_{it} =number of workers employed by firm i at time t,
- K_{it} =tangible fixed assets of firm i at time t, 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.
- M_{it} =total costs of the goods sold minus the cost of employees, deflated by a provincial producers' price index of industrial products,
- I_{it} =data for investment is derived from the law of motion of capital $K_{it+1} = (1-\delta)K_{it} + I_{it}$. Due to this calculation, we have no data on investment for the last period of our sample.

All price indices are taken from various editions of China Statistical Yearbook.

B Regional Distribution of FDI in China

See attached part with tables and figures.

C Sectoral Distribution of FDI in China

See attached part with tables and figures.

D Olley and Pakes (1996)

Assume a Cobb-Douglas production function

$$Y_{it} = L_{it}^{\beta_l} M_{it}^{\beta_m} K_{it}^{\beta_k} \exp(\beta_0 + \omega_{it} + u_{it}^q), \tag{10}$$

where i and t indicate plant and time respectively. Y_{it} represents output, L_{it}, M_{it} and K_{it} stand for labor, materials and capital respectively. The economies of scale are captured by the sum of the coefficients $\beta_l + \beta_m + \beta_k$. Taking logs yields the following regression equation

$$\begin{aligned} y_{it} &= \beta_0 + \beta x_{it} + \beta_k k_{it} + e_{it} \\ e_{it} &= \omega_{it} + u_{it}^q, \end{aligned} \tag{11}$$

where x_{it} is a vector of the variable intermediate inputs labor and materials. The plant specific error term e_{it} consists of two parts: the plant productivity ω_{it} which is observed by the firm but not by the econometrician, and the random shock to productivity u_{it}^q. Labor and materials are assumed to be freely variable inputs, while capital is a fixed factor subject to an investment process ($K_{it+1} = (1-\delta)K_{it} + I_{it}$). The asymmetric information about ω_{it} causes two bias in the ordinary least squares (OLS) estimates: a simultaneity bias and a selection bias. Olley and Pakes (1996) develop a semi-parametric approach to account for the endogeneity of input selection by the firm. By proxying unobserved productivity by capital and investment, they obtain consistent estimates for the input coefficients.[24]

Firms maximize the expected value of both current and future profits. At time t, a firm decides whether to produce or exit, and the investment level if they decide to stay. A firm's investment decision depends on its current stock of capital and its observed productivity. Provided that the equilibrium investment function is a strictly increasing function with respect to the productivity shock, and that $i_t > 0$, unobserved productivity can be expressed as a function of observable investment and capital. For ease of notation the firm index is dropped:

$$\omega_t = i_t^{-1}(i_t, k_t) = \theta(i_t, k_t). \tag{12}$$

Substituting (12) into (11) yields the first stage of the estimation procedure

$$y_t = \beta x_t + \lambda_t(i_t, k_t) + u_{it}^q, \tag{13}$$

where

$$\lambda_t(i_t, k_t) = \beta_0 + \beta_k k_t + \theta(i_t, k_t). \tag{14}$$

[24] Since our database does however not allow us to distinguish between whether firms exit from the market or whether data is simply unavailable, we are unable to correct for the selection bias. In the discussion of the OP methodology we will therefore focus on the simultaneity bias.

The functional form of λ_{it} is not known, but it can be approximated by a higher order polynomial series in capital and investment.[25] The estimation of the partially linear model in (13) yields consistent estimates for the coefficients on the variable inputs (i.e. labor and material). Since k_{it} is collinear with the non-parametric function, we can not identify β_k. In order to consistently estimate the capital coefficient, the effect of capital on output still needs to be separated from its effect on a plant's investment decision.

Consider the expectation of $y_{t+1} - \beta x_{it+1}$

$$E[y_{t+1} - \beta x_{it+1}|k_{t+1}] = \beta_0 + \beta_k k_{t+1} + E[\omega_{t+1}|\omega_t] \equiv \beta_k k_{t+1} + g(\omega_t), \tag{15}$$

where the expectation of next period's productivity is a function of productivity today, denoted by $g(\omega_t)$. Productivity is assumed to follow a first order Markov process ($\omega_{t+1} = \omega_t + \xi_{t+1}$), where productivity can be expressed using expression (14) and (12), i.e. $\omega_t = \theta(i_t, k_t) = \lambda_t(i_t, k_t) - \beta_0 - \beta_k k_t$. This gives

$$y_{t+1} - \hat{\beta} x_{it+1} = \beta_k k_{t+1} + g(\hat{\lambda}_t - \beta_k k_t) + \xi_{t+1} + u^q_{t+1},$$

where $\hat{\beta}$ is the estimate for β out of the first stage, and $g(.)$ is approximated by a high-order polynomial expression of capital and the fitted values of λ_t from the first stage. Since capital enters both in contemporaneous and future values, the second stage has to be estimated using non-linear least squares. Ignoring this structure, i.e. not restricting the coefficients on capital to be the same wherever it appears in the estimation of the second stage, would not yield efficient estimates.

E De Loecker (2007) methodology

Consider again a production function of the following form

$$Q_{it} = L_{it}^{\beta_l} M_{it}^{\beta_m} K_{it}^{\beta_k} \exp(\beta_0 + \omega_{it} + u^q_{it}), \tag{16}$$

where Q_{it} is the physical output of firm i in period t, productivity is denoted by ω_{it} and u^q_{it} is an *i.i.d.* component. Since data on physical output volumes are unavailable, output is proxied by sales revenues deflated with an region-wide price deflator, $\tilde{R}_{it} = \frac{P_{it}Q_{it}}{P_{It}}$. This approximation is valid when firms all face the same price and have no price setting power. In an imperfectly competitive environment output prices will differ among firms, hereby contaminating the relationship between inputs and output by variation in prices and demand elasticities. By introducing explicitly a demand system Klette and Griliches (1996) are able to express the omitted price variable in terms of the firm's output growth relative to the industry output. De Loecker (2007) afterwards extends their framework by controlling for the simultaneity bias using OP and allowing for multi-product firms.[26]

Assume that each firm produces one product for which it faces the following demand

[25] Olley and Pakes (1996) suggest both a kernel and a series estimator, but favor the former since its limiting distribution is known.

[26] In the original framework the analysis is based on industrial price deflators. Since there are only regional price deflators available for the Chinese manufacturing we discuss the De Loecker (2007) approach in terms of regional prices. Nevertheless, the underlying idea is identical.

function

$$Q_{it} = Q_{It} \left(\frac{P_{it}}{P_{It}} \right)^{\eta} \exp(u_{it}^d). \tag{17}$$

Demand for firm's i product depends on total regional demand Q_{It}, and the firm's market share which is determined by its price relative to the regional price P_{It}, and the elasticity of substitution η. The elasticity of substitution is allowed to differ among industries and $-\infty < \eta < -1$. The term u_{it}^d represents an idiosyncratic shock specific to firm i. Taking logs and writing price as a function of the other variables gives

$$p_{it} = \frac{1}{\eta}(q_{it} - q_{It} - u_{it}^d) + p_{It}. \tag{18}$$

Plugging in this expression for price into the deflated revenue function $\tilde{r}_{it} = p_{it} + q_{it} - p_{It}$, gives

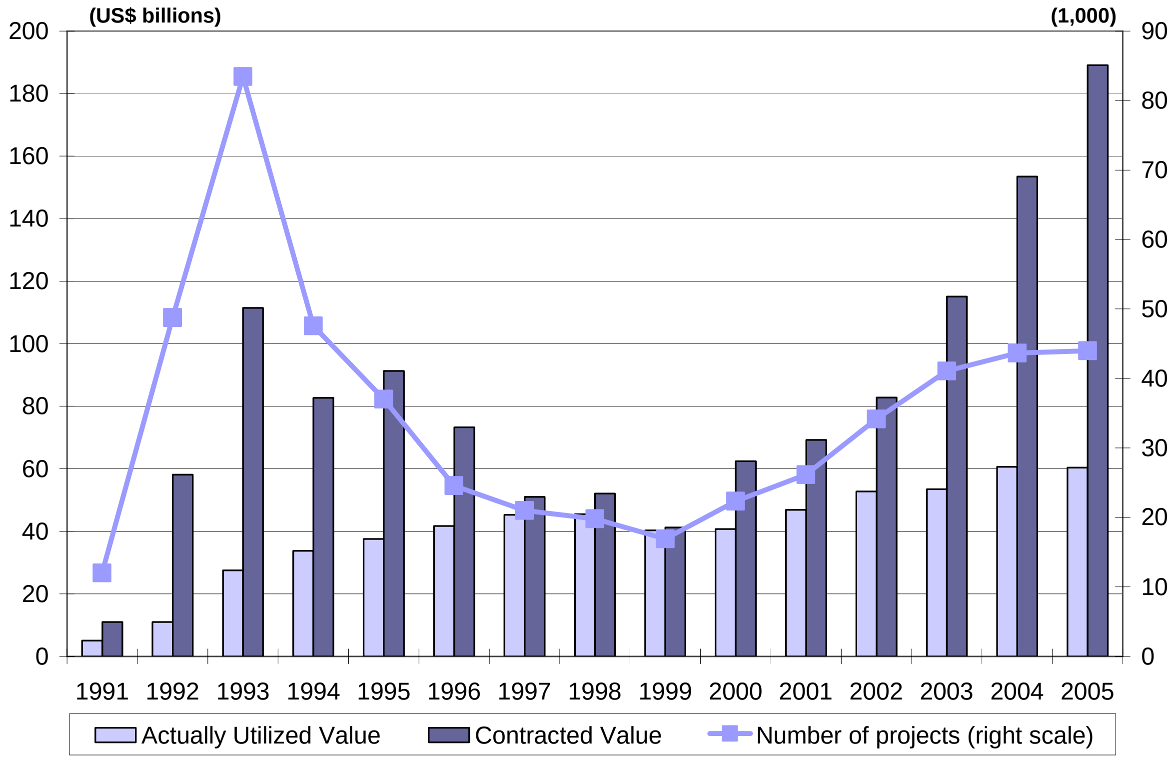
$$\tilde{r}_{it} = \left(\frac{\eta + 1}{\eta} \right) q_{it} - \frac{1}{\eta} q_{It} - \frac{1}{\eta} u_{it}^d. \tag{19}$$

When we replace q_{it} with the log-version of the production function in equation (16), we have an expression that can be estimated without the omitted price variable problem

$$\tilde{r}_{it} = \left(\frac{\eta + 1}{\eta} \right) (\beta_0 + \beta_l l_{it} + \beta_m m_{it} + \beta_k k_{it}) - \frac{1}{\eta} q_{It} + \left(\frac{\eta + 1}{\eta} \right) (\omega_{it} + u_{it}^q) - \frac{1}{\eta} u_{it}^d, \tag{20}$$

where q_{it} is poxied by total deflated sales within a certain province. Expressing deflated sales revenue as a function of demand and supply factors, allows us to take into account the degree of competition on the output market, and in particular the variation in prices across firms. In case there is no product differentiation in the market, the elasticity of substitution between differentiated goods tends to infinity. From equation (20) can be seen that the bias from neglecting the price differences will disappear, implying that deflated sales would be a valid measure for quality-adjusted output. Equation (20) is subsequently estimated using the OP methodology to correct for the simultaneity bias. The only difference is that the demand variation (q_{it}) is introduced in the estimation as an additional term. The estimated coefficient on regional output delivers an estimate for the elasticity of substitution, from which the relevant mark-ups $\left(\frac{\eta}{\eta+1} \right)$ can be calculated. Multiplying the estimated β-parameters on the input variables by this mark-up, gives us the true production function coefficients and the related returns to scale ($\varepsilon = \beta_l + \beta_m + \beta_k$).

Figure 1: Foreign Direct Investment inflows in China (1991-2005)



Note: 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.

Source: China Statistical Yearbook

Table 1: Summary statistics for manufacturing plants in China

Variable	Domestic	Foreign	HMT	Non-HMT	JV	WFOE
Number of employees	968	876	924	756	793	959
Sales	32,840	47,142	36,224	50,081	49,358	44,282
Value added	4,901	7,266	5,805	7,759	7,815	6,411
Value added per worker	6.76	11.07	6.95	13.75	12.00	9.82
Capital per worker	16.98	20.80	13.95	25.91	24.64	16.83
Investment per worker	2.89	4.83	3.39	5.58	5.37	4.24
Labor productivity	47.30	80.78	50.38	98.24	88.88	72.28

Number of firms						
in 2002	7,232	5,553	2,915	2,315	2,915	2,620
in 2003	7,784	6,136	3,189	2,625	3,121	3,000
in 2004	8,463	6,903	3,573	3,012	3,400	3,491

Notes:
- The summary statistics represent the mean over the period 2002-2004.
- The number of employees is expressed in thousands of workers.
- The remaining variables are expressed in thousands of US Dollars, using provincial price indices to deflate.
- The distinction between domestic and foreign plants is based on their legal form.
- HMT: Hong Kong, Macau and Taiwan + tax paradises (Bermuda, Bahamas, Cayman Islands and British Virgin Islands.)

Table 2: Summary statistics for exporting versus non-exporting plants

Variable	Domestic Exporters	Domestic Non-exporters	Exporters	Non-exporters
Number of employees	1,402	769	1,185	784
Sales	50,286	24,875	55,169	34,051
Exports	11,379	0	24,349	0
Value added	7,551	3,623	8,151	5,209
Value added per worker	5.37	7.43	8.56	11.52
Capital per worker	11.17	19.63	16.15	29.38
Investment per worker	2.10	3.50	2.96	4.10
Labor productivity	39.86	50.70	65.21	79.18

Number of firms				
In 2002	3,126	4,106	7,388	5,397
In 2003	3,439	4,344	8,223	5,696
In 2004	795	807	2,113	1,146

Notes:
- The group of domestic firms excludes Sino-foreign JVs.
- The summary statistics represent the mean over the period 2002-2004.
- The number of employees is expressed in thousands of workers.
- The remaining variables are expressed in thousands of US Dollars, using provincial price indices to deflate.
- The distinction between domestic and foreign plants is based on their legal form.

Table 3: Sectoral spillovers in the Chinese manufacturing sector

TFP as dependent variable	**(1)**	**(2)**	**(3)**	**(4)**
JV	0.166	0.180	0.175	0.173
	(0.011)***	(0.012)***	(0.012)***	(0.012)***
Exporter	-	0.092	0.087	0.087
		(0.019)***	(0.019)***	(0.019)***
SEZ	-	-	0.089	0.047
			(0.020)***	(0.014)***
Spillover	0.046	0.173	0.190	0.145
	(0.025)*	(0.030)***	(0.035)***	(0.032)***
Spillover x Exporter	-	-0.235	-0.224	-0.225
		(0.039)***	(0.039)***	(0.039)***
Spillover x SEZ	-	-	-0.058	-
			(0.040)	
Spillover x ETDZ	-	-	-	0.064
				(0.029)**
Spillover x FTZ	-	-	-	-0.033
				(0.030)
Spillover x HIDZ	-	-	-	0.033
				(0.028)
Spillover x BECZ	-	-	-	-0.160
				(0.122)
Spillover x EPZ	-	-	-	-0.035
				(0.033)
Observations	32,960	23,597	23,597	23,597
R-squared	0.499	0.515	0.517	0.518

Notes: The dependent variable is the logarithm of *TFP* estimated using the Olley-Pakes methodology. All regressions include 2-digit sector, province, and time dummies - Robust standard errors in parentheses - */**/*** significant at 10/5/1%.

Table 4: Sectoral spillovers using different methodologies

TFP as dependent variable	**LP**	**TFP-OLS**	**TFP-OP**	**LP**	**TFP-OLS**	**TFP-OP**
JV	0.226	0.095	0.175	0.218	0.092	0.173
	(0.020)***	(0.006)***	(0.012)***	(0.020)***	(0.006)***	(0.012)***
Exporter	-0.067	0.027	0.087	-0.073	0.029	0.087
	(0.040)*	(0.011)**	(0.019)***	(0.040)*	(0.011)***	(0.019)***
SEZ	-0.008	0.053	0.089	0.013	0.001	0.047
	(0.043)	(0.011)***	(0.020)***	(0.024)	(0.007)	(0.014)***
Spillover	0.285	0.132	0.190	0.255	0.072	0.145
	(0.081)***	(0.022)***	(0.035)***	(0.079)***	(0.020)***	(0.032)***
Spillover x Exporter	-0.308	-0.095	-0.224	-0.294	-0.098	-0.225
	(0.089)***	(0.023)***	(0.039)***	(0.089)***	(0.023)***	(0.039)***
Spillover x SEZ	0.228	-0.066	-0.058	-	-	-
	(0.090)**	(0.023)***	(0.040)			
K_intensity	0.428	-	-	0.425	-	-
	(0.008)***			(0.008)***		
Spillover x ETDZ	-	-	-	0.132	0.039	0.064
				(0.056)**	(0.015)**	(0.029)**
Spillover x FTZ	-	-	-	-0.095	-0.036	-0.033
				(0.064)	(0.016)**	(0.030)
Spillover x HIDZ	-	-	-	0.213	0.062	0.033
				(0.055)***	(0.015)***	(0.028)
Spillover x BECZ	-	-	-	0.055	0.049	-0.160
				(0.539)	(0.128)	(0.122)
Spillover x EPZ	-	-	-	0.062	0.008	-0.035
				(0.070)	(0.020)	(0.033)
Observations	23,595	23,597	23,597	23,595	23,597	23,597
R-squared	0.493	0.565	0.517	0.495	0.567	0.518

Notes: The dependent variable is the log form of either labor productivity (Column 1 and 4), TFP estimated using OLS (Column 2 and 5), or TFP estimated using the Olley-Pakes methodology (Column 3 and 6). In the labor-productivity specification we additionally control for the capital intensity of a plant when running the regressions. All regressions include 2-digit sector, province, and time dummies - Robust standard errors in parentheses - */**/*** significant at 10/5/1%.

Table 5: Spillovers and the role of ownership structure

TFP as dependent variable	(1)	(2)
JV	0.162	0.169
	(0.011)***	(0.012)***
Exporter	-	0.077
		(0.018)***
SEZ	-	0.042
		(0.016)**
Spillover_JV	0.184	0.148
	(0.030)***	(0.046)***
Spillover_WFOE	-0.090	0.187
	(0.042)**	(0.074)**
Spillover_JV x Exporter	-	-0.172
		(0.054)***
Spillover_WFOE x Exporter	-	-0.250
		(0.073)***
Spillover_JV x SEZ	-	0.251
		(0.053)***
Spillover_WFOE x SEZ	-	-0.243
		(0.077)***
Observations	32,960	23,597
R-squared	0.500	0.519

Notes: The dependent variable is the logarithm of *TFP* estimated using the Olley-Pakes methodology. All regressions include 3-digit sector, city, and time dummies - Robust standard errors in parentheses - */**/*** significant at 10/5/1%.

Table 6: Spillovers according origin

TFP as dependent variable	HMT (OP)	Non-HMT (OP)
JV	0.222	0.123
	(0.015)***	(0.016)***
Region dummy	-0.097	0.095
	(0.021)***	(0.021)***
Exporter	0.063	0.026
	(0.015)***	(0.014)*
SEZ	0.075	0.082
	(0.015)***	(0.015)***
Spillover	0.248	0.196
	(0.060)***	(0.043)***
Spillover x Exporter	-0.383	-0.154
	(0.070)***	(0.043)***
Spillover x SEZ	-0.067	-0.084
	-0.070	(0.046)*
Observations	23,789	23,678
R-squared	0.519	0.519

Notes: The dependent variable is the logarithm of *TFP* estimated using the Olley-Pakes methodology. All regressions include 3-digit sector, city, and time dummies - Robust standard errors in parentheses - */**/*** significant at 10/5/1%. HMT stands for Hong Kong, Macau and Taiwan + tax paradises (Bermuda, Bahamas, Cayman Islands and British Virgin Islands.)

Table 7: Robustness checks

TFP as dependent variable	**Original (OP)**	**Employment [a]**	**Regional [b]**	**HHI [c]**	**DL**
JV	0.175	0.176	0.167	0.175	0.077
	(0.012)***	(0.012)***	(0.012)***	(0.012)***	(0.012)***
Exporter	0.087	0.094	0.056	0.088	-0.007
	(0.019)***	(0.017)***	(0.011)***	(0.019)***	(0.017)
SEZ	0.089	0.104	0.058	0.089	0.042
	(0.020)***	(0.017)***	(0.018)***	(0.020)***	(0.018)**
HHI3	-	-	-	0.351	-
				(0.084)***	
Spillover	0.190	0.277	0.166	0.246	0.070
	(0.035)***	(0.046)***	(0.025)***	(0.039)***	(0.033)**
Spillover x Exporter	-0.224	-0.299	-0.171	-0.230	-0.042
	(0.039)***	(0.046)***	(0.026)***	(0.039)***	(0.038)
Spillover x SEZ	-0.058	-0.110	-0.015	-0.058	0.024
	(0.040)	(0.046)**	(0.036)	(0.040)	(0.040)
Spillover x HHI3	-	-	-	-0.568	-
				(0.160)***	
Observations	23,597	23,597	23,597	23,597	23,597
R-squared	0.517	0.519	0.518	0.518	0.439

Notes: The dependent variable is the logarithm of *TFP* estimated using the Olley-Pakes methodology (except in last column -DL- where *TFP* is estimated using the De Loecker methodology). All regressions include 3-digit sector, city, and time dummies - Robust standard errors in parentheses - */**/*** significant at 10/5/1%.

[a] Employment spillovers are measured by the share of foreign employment in total employment at the 3-digit US SIC87 level.

[b] Regional spillovers are defined as the share of foreign sales in total sales at the city level.

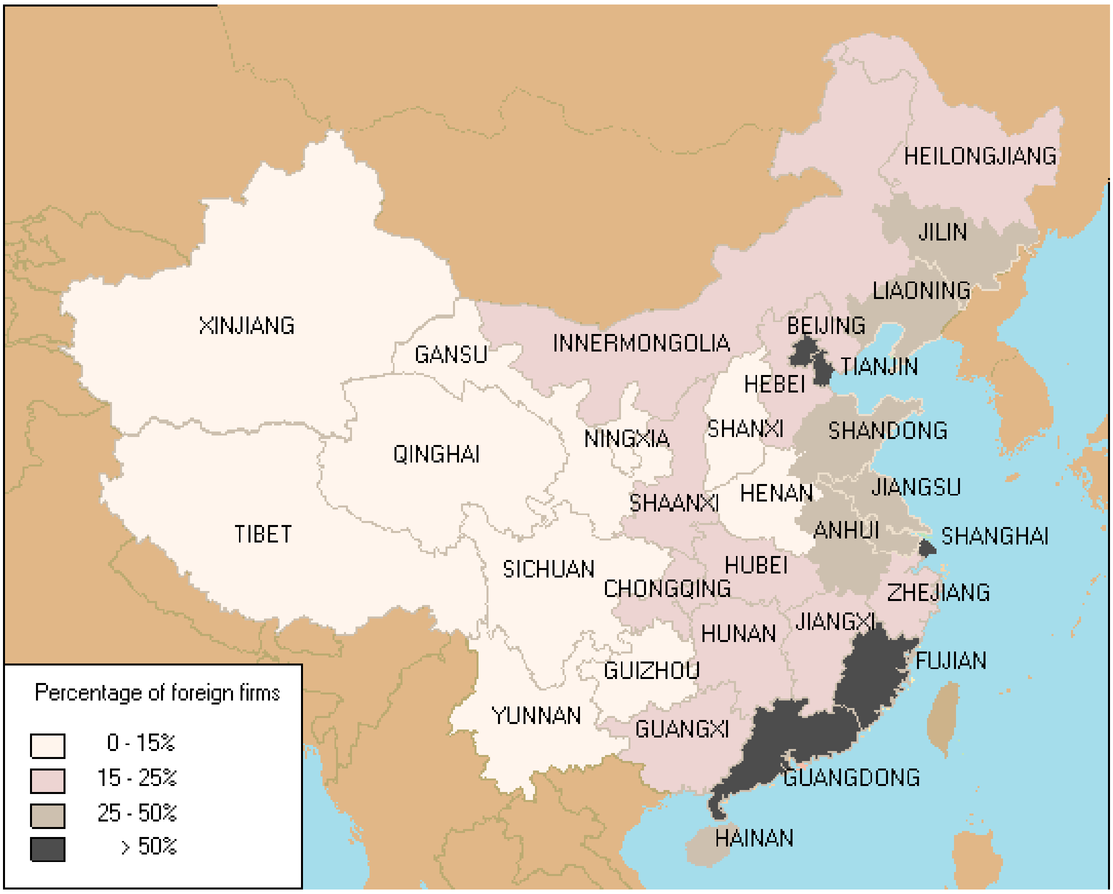
[c] The Herfindahl-Hirschman Index is calculated at the 3-digit US SIC87 level.

Table 8: Herfindahl-Hirschman Index

USSIC	Description	HHI
20	Food and kindred products	0.03
21	Tobacco products	0.33
22	Textile mill products	0.03
23	Apparel and other textile products	0.03
24	Lumber and wood products	0.11
25	Furniture and fixtures	0.06
26	Paper and allied products	0.06
27	Printing and publishing	0.12
28	Chemicals and allied products	0.02
29	Petroleum and coal products	0.10
30	Rubber and miscellaneous plastics products	0.03
31	Leather and leather products	0.04
32	Stone, clay, and glass products	0.04
33	Primary metal industries	0.03
34	Fabricated metal products	0.05
35	Industrial machinery and equipment	0.04
36	Electronic and other electric equipment	0.03
37	Transportation equipment	0.06
38	Instruments and related products	0.07
39	Miscellaneous manufacturing industries	0.05

Note: The HHI index is calculated at the 3-digit US SIC87 level. The indices represent the mean competition degree within a sector over the three years of our dataset.

Appendix B: Regional Distribution of FDI in China



Appendix C: Sectoral distribution of FDI in China

US SIC	Description	Number of firms			Distribution of foreign firms across sectors		Foreign share in total sales
		Total	JV	WFOE	HMT	Non-HMT	
20	Food and kindred products	1,175	300	154	6.46%	8.56%	46.33%
21	Tobacco products	27	3	1	0.06%	0.04%	6.59%
22	Textile mill products	1,370	259	188	9.13%	5.44%	30.46%
23	Apparel and other textile products	1,128	334	310	11.01%	10.14%	52.54%
24	Lumber and wood products	124	31	17	0.78%	0.77%	30.43%
25	Furniture and fixtures	183	46	67	2.26%	1.40%	70.17%
26	Paper and allied products	358	81	46	2.23%	1.90%	48.69%
27	Printing and publishing	119	39	20	1.44%	0.49%	55.99%
28	Chemicals and allied products	1,319	252	128	5.05%	7.34%	36.34%
29	Petroleum and coal products	128	17	11	0.25%	0.70%	24.81%
30	Rubber and miscellaneous plastics products	655	156	234	7.59%	4.84%	60.90%
31	Leather and leather products	514	122	198	5.83%	4.49%	60.64%
32	Stone, clay, and glass products	857	140	56	3.20%	3.26%	28.40%
33	Primary metal industries	834	125	63	2.98%	3.05%	23.66%
34	Fabricated metal products	539	117	120	4.11%	3.62%	46.83%
35	Industrial machinery and equipment	1,128	197	261	6.05%	8.99%	54.74%
36	Electronic and other electric equipment	1,930	537	672	18.16%	21.55%	67.05%
37	Transportation equipment	691	164	100	2.76%	5.97%	55.28%
38	Instruments and related products	257	59	91	2.16%	2.77%	63.06%
39	Miscellaneous manufacturing industries	584	142	263	8.50%	4.67%	67.90%
	Total	13,920	3,121	3,000	100.00%	100.00%	48.32%

Notes:

- The distinction between domestic and Sino-foreign Joint-Ventures (JV) and Wholly Foreign Owned Enterprises (WFOE) respectively is based on their legal form,
- HMT: Hong Kong, Macau and Taiwan + tax paradises (Bermuda, Bahamas, Cayman Islands and British Virgin Islands).

Appendix F.1: Estimates of production function – Domestic plants

	OLS		OP		DL	
	mean	s.e.	mean	s.e.	mean	s.e.
Food and kindred products						
Labor	0.090	0.011	0.082	0.015	0.082	0.015
Materials	0.842	0.011	0.831	0.016	0.829	0.018
Capital	0.055	0.006	0.059	0.015	0.058	0.013
Tobacco products						
Labor	0.041	0.044	0.073	0.042	0.058	0.069
Materials	0.810	0.027	0.771	0.023	0.770	0.022
Capital	0.072	0.039	0.044	0.089	0.037	0.085
Textile mill products						
Labor	0.073	0.009	0.066	0.013	0.074	0.015
Materials	0.878	0.014	0.863	0.022	0.877	0.025
Capital	0.030	0.006	0.052	0.014	0.053	0.013
Apparel and other textile products						
Labor	0.128	0.012	0.096	0.012	0.096	0.013
Materials	0.844	0.011	0.859	0.012	0.859	0.013
Capital	0.037	0.007	0.035	0.012	0.034	0.011
Lumber and wood products						
Labor	0.057	0.017	0.025	0.025	0.021	0.025
Materials	0.902	0.011	0.909	0.017	0.914	0.018
Capital	0.038	0.007	0.052	0.019	0.021	0.018
Furniture and fixtures						
Labor	0.110	0.023	0.117	0.029	0.117	0.029
Materials	0.855	0.016	0.833	0.020	0.833	0.021
Capital	0.017	0.013	0.040	0.017	0.040	0.017
Paper and allied products						
Labor	0.113	0.032	0.059	0.025	0.081	0.028
Materials	0.825	0.050	0.800	0.051	0.822	0.057
Capital	0.040	0.014	0.100	0.013	0.112	0.012
Printing and publishing						
Labor	0.045	0.028	0.028	0.038	-0.002	0.036
Materials	0.825	0.022	0.858	0.027	0.861	0.026
Capital	0.040	0.024	0.109	0.030	0.100	0.031
Chemicals and allied products						
Labor	0.079	0.013	0.066	0.017	0.072	0.017
Materials	0.740	0.018	0.706	0.026	0.715	0.028
Capital	0.107	0.012	0.080	0.031	0.083	0.032
Petroleum and coal products						
Labor	0.084	0.042	0.122	0.046	0.123	0.045
Materials	0.844	0.034	0.824	0.035	0.811	0.039
Capital	0.063	0.044	0.018	0.038	0.026	0.043
Rubber and miscellaneous plastics products						
Labor	0.081	0.014	0.046	0.016	0.048	0.017
Materials	0.866	0.019	0.886	0.015	0.884	0.016
Capital	0.029	0.010	0.046	0.015	0.047	0.014
Leather and leather products						
Labor	0.155	0.022	0.124	0.026	0.127	0.025
Materials	0.804	0.024	0.822	0.046	0.864	0.046
Capital	0.048	0.012	0.072	0.021	0.075	0.024

Appendix F.1 continue

	OLS		OP		DL	
	mean	s.e.	mean	s.e.	mean	s.e.
Stone, clay, and glass products						
Labor	0.137	0.017	0.103	0.013	0.101	0.013
Materials	0.850	0.011	0.861	0.008	0.866	0.010
Capital	0.030	0.013	0.044	0.018	0.044	0.018
Primary metal industries						
Labor	0.063	0.006	0.058	0.008	0.061	0.008
Materials	0.906	0.007	0.887	0.011	0.894	0.011
Capital	0.030	0.005	0.030	0.010	0.031	0.009
Fabricated metal products						
Labor	0.096	0.014	0.099	0.019	0.099	0.019
Materials	0.844	0.014	0.821	0.016	0.821	0.016
Capital	0.050	0.009	0.049	0.023	0.053	0.021
Industrial machinery and equipment						
Labor	0.093	0.012	0.098	0.014	0.098	0.014
Materials	0.818	0.013	0.803	0.019	0.804	0.019
Capital	0.061	0.008	0.060	0.015	0.060	0.016
Electronic and other electric equipment						
Labor	0.109	0.020	0.096	0.022	0.096	0.022
Materials	0.802	0.017	0.805	0.019	0.805	0.020
Capital	0.081	0.013	0.089	0.015	0.088	0.016
Transportation equipment						
Labor	0.109	0.014	0.081	0.011	0.083	0.012
Materials	0.850	0.013	0.844	0.015	0.843	0.015
Capital	0.037	0.008	0.033	0.018	0.032	0.018
Instruments and related products						
Labor	0.052	0.024	0.007	0.037	0.004	0.037
Materials	0.804	0.030	0.776	0.045	0.793	0.050
Capital	0.085	0.021	0.021	0.069	0.021	0.062
Miscellaneous manufacturing industries						
Labor	0.120	0.021	0.105	0.023	0.105	0.023
Materials	0.816	0.022	0.812	0.024	0.813	0.025
Capital	0.065	0.014	0.109	0.020	0.110	0.021

Note: To allow the factor proportions and the economies of scale varying across the different sectors, the production function is estimated for each of the twenty US SIC 2-digit sectors separately. For sector "Tobacco products" we do not have enough observations to estimate the production for domestic versus joint-ventures separately. The coefficients are estimates for both groups jointly.

Appendix F.2: Estimates of production function – Sino-foreign joint-ventures

	OLS		OP		DL	
	mean	s.e.	mean	s.e.	mean	s.e.
Food and kindred products						
Labor	0.064	0.018	0.031	0.019	0.032	0.019
Materials	0.839	0.015	0.830	0.016	0.829	0.016
Capital	0.099	0.016	0.012	0.037	0.011	0.040
Tobacco products						
Labor	0.041	0.044	0.073	0.042	0.058	0.069
Materials	0.810	0.027	0.771	0.023	0.770	0.022
Capital	0.072	0.039	0.044	0.089	0.037	0.085
Textile mill products						
Labor	0.073	0.012	0.062	0.014	0.062	0.014
Materials	0.880	0.014	0.877	0.019	0.877	0.020
Capital	0.020	0.008	0.038	0.022	0.038	0.022
Apparel and other textile products						
Labor	0.176	0.022	0.148	0.022	0.149	0.023
Materials	0.759	0.019	0.772	0.021	0.771	0.021
Capital	0.060	0.012	0.053	0.025	0.055	0.026
Lumber and wood products						
Labor	0.000	0.000	0.000	0.000	0.000	0.000
Materials	0.000	0.000	0.000	0.000	0.000	0.000
Capital	0.000	0.000	0.000	0.000	0.000	0.000
Furniture and fixtures						
Labor	0.086	0.024	0.054	0.017	0.053	0.015
Materials	0.869	0.024	0.879	0.022	0.876	0.023
Capital	0.044	0.016	0.049	0.031	0.055	0.032
Paper and allied products						
Labor	0.036	0.037	0.020	0.026	0.022	0.028
Materials	0.901	0.037	0.916	0.040	0.918	0.039
Capital	0.021	0.023	0.131	0.048	0.131	0.046
Printing and publishing						
Labor	0.042	0.025	0.058	0.045	0.084	0.039
Materials	0.901	0.024	0.914	0.039	0.927	0.037
Capital	0.021	0.023	-0.005	0.071	0.002	0.052
Chemicals and allied products						
Labor	0.151	0.029	0.157	0.039	0.157	0.039
Materials	0.664	0.035	0.657	0.044	0.654	0.047
Capital	0.138	0.020	0.091	0.046	0.083	0.048
Petroleum and coal products						
Labor	0.037	0.025	0.011	0.037	0.016	0.033
Materials	0.851	0.032	0.820	0.055	0.847	0.063
Capital	0.028	0.023	0.055	0.050	0.035	0.038
Rubber and miscellaneous plastics products						
Labor	0.068	0.013	0.048	0.011	0.049	0.011
Materials	0.861	0.019	0.885	0.016	0.885	0.016
Capital	0.051	0.010	0.058	0.018	0.058	0.020
Leather and leather products						
Labor	0.201	0.045	0.112	0.025	0.114	0.024
Materials	0.704	0.054	0.832	0.034	0.877	0.034
Capital	0.070	0.032	0.066	0.093	0.072	0.097

Appendix F.2 continue

	OLS		OP		DL	
	mean	s.e.	mean	s.e.	mean	s.e.
Stone, clay, and glass products						
Labor	0.037	0.021	0.060	0.024	0.064	0.026
Materials	0.848	0.043	0.801	0.095	0.791	0.101
Capital	0.061	0.019	0.084	0.039	0.072	0.048
Primary metal industries						
Labor	0.049	0.009	0.056	0.012	0.069	0.013
Materials	0.903	0.014	0.892	0.013	0.912	0.013
Capital	0.061	0.009	0.051	0.016	0.046	0.011
Fabricated metal products						
Labor	0.023	0.012	0.026	0.017	0.025	0.017
Materials	0.906	0.016	0.888	0.021	0.887	0.022
Capital	0.051	0.012	0.075	0.035	0.076	0.031
Industrial machinery and equipment						
Labor	0.094	0.046	0.029	0.015	0.032	0.015
Materials	0.843	0.036	0.884	0.014	0.886	0.014
Capital	0.024	0.025	0.052	0.010	0.050	0.011
Electronic and other electric equipment						
Labor	0.060	0.017	0.043	0.022	0.044	0.021
Materials	0.856	0.028	0.876	0.030	0.876	0.030
Capital	0.046	0.011	-0.019	0.037	0.024	0.035
Transportation equipment						
Labor	0.030	0.018	0.006	0.016	0.004	0.017
Materials	0.918	0.017	0.914	0.018	0.912	0.018
Capital	0.051	0.012	0.022	0.026	0.027	0.025
Instruments and related products						
Labor	0.000	0.022	-0.015	0.027	-0.015	0.029
Materials	0.825	0.054	0.917	0.047	0.917	0.047
Capital	0.083	0.032	-0.024	0.118	-0.026	0.114
Miscellaneous manufacturing industries						
Labor	0.166	0.024	0.176	0.035	0.170	0.035
Materials	0.773	0.031	0.738	0.063	0.735	0.064
Capital	0.062	0.015	0.109	0.030	0.112	0.032

Note: To allow the factor proportions and the economies of scale varying across the different sectors, the production function is estimated for each of the twenty US SIC 2-digit sectors separately. For sector "Tobacco products" we do not have enough observations to estimate the production for domestic versus joint-ventures separately. The coefficients are estimates for both groups jointly.

Appendix F.3: Estimated output coefficients (β_q) across sectors, using De Loecker (2007)

USSIC	Description	Domestic				JV			
		beta_q	s.e.	t-stat	markup	beta_q	s.e.	t-stat	markup
20	Food and kindred products	0.009	0.011	0.81	1.01	0.010	0.019	0.54	1.01
21	Tobacco products	0.030	0.087	0.35	1.03	0.030	0.087	0.35	1.03
22	Textile mill products	0.025	0.013	1.94	1.03	-0.001	0.012	-0.05	1.00
23	Apparel and other textile products	-0.003	0.012	-0.21	1.00	0.014	0.021	0.68	1.01
24	Lumber and wood products	-0.011	0.014	-0.75	0.99	0.147	0.217	0.68	1.17
25	Furniture and fixtures	-0.002	0.020	-0.12	1.00	0.015	0.020	0.74	1.02
26	Paper and allied products	0.060	0.023	2.55	1.06	-0.015	0.018	-0.83	0.99
27	Printing and publishing	-0.054	0.025	-2.15	0.95	-0.064	0.024	-2.63	0.94
28	Chemicals and allied products	0.029	0.012	2.35	1.03	0.013	0.033	0.40	1.01
29	Petroleum and coal products	0.039	0.031	1.26	1.04	-0.048	0.091	-0.53	0.95
30	Rubber and miscellaneous plastics products	0.010	0.014	0.73	1.01	0.005	0.013	0.40	1.01
31	Leather and leather products	0.049	0.024	2.06	1.05	0.052	0.027	1.94	1.05
32	Stone, clay, and glass products	-0.011	0.007	-1.48	0.99	0.024	0.026	0.94	1.02
33	Primary metal industries	0.013	0.006	2.17	1.01	0.034	0.012	2.88	1.04
34	Fabricated metal products	-0.003	0.012	-0.22	1.00	0.007	0.015	0.45	1.01
35	Industrial machinery and equipment	0.000	0.009	-0.02	1.00	-0.025	0.014	-1.84	0.98
36	Electronic and other electric equipment	0.001	0.014	0.07	1.00	-0.005	0.013	-0.43	0.99
37	Transportation equipment	0.005	0.008	0.63	1.01	0.012	0.014	0.89	1.01
38	Instruments and related products	-0.054	0.031	-1.72	0.95	-0.003	0.041	-0.07	1.00
39	Miscellaneous manufacturing industries	-0.009	0.018	-0.50	0.99	0.027	0.028	0.96	1.03

Note: The coefficients represent the means and standard deviations of the estimated demand variation in sector *j*. The absolute values of the means are a measure for the sectoral Lerner indices.

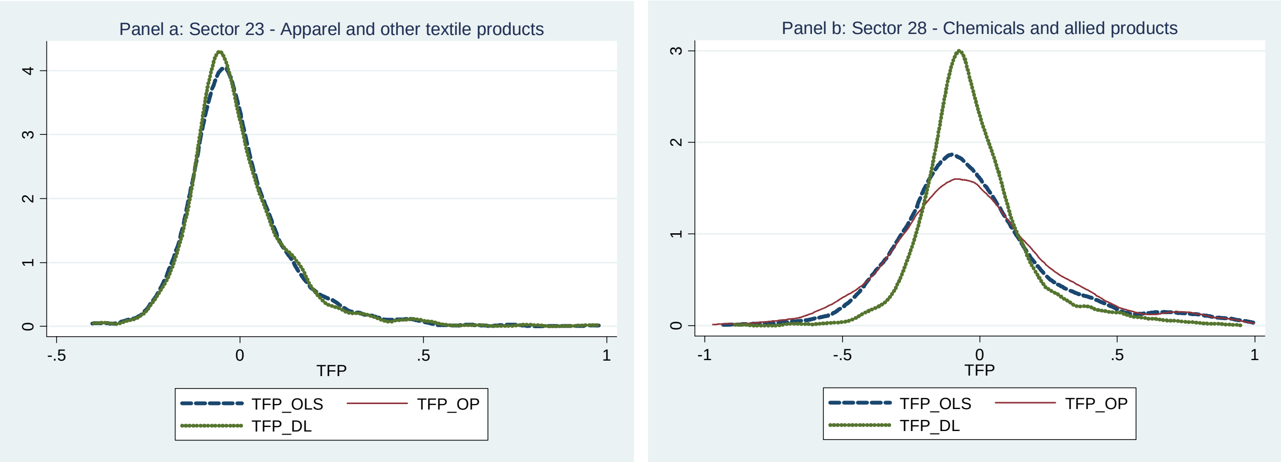
Appendix F.4: Estimated Total Factor Productivity

ussic2	OLS						OP						DL					
	Mean			Standard deviation			Mean			Standard deviation			Mean			Standard deviation		
	D	JV	D-JV	D	JV	D-JV	D	JV	D-JV	D	JV	D-JV	D	JV	D-JV	D	JV	D-JV
20	0.77	0.67	0.09	0.25	0.28	-0.03	0.89	1.74	-0.86	0.25	0.31	-0.06	0.91	1.75	-0.84	0.00	0.31	-0.31
21	1.38	1.64	-0.25	0.23	0.50	-0.27	1.79	2.05	-0.26	0.24	0.49	-0.25	1.96	2.21	-0.25	0.25	0.48	-0.23
22	0.61	0.71	-0.10	0.15	0.14	0.01	0.61	0.67	-0.05	0.15	0.14	0.01	0.36	0.67	-0.31	0.24	0.14	0.10
23	0.55	0.87	-0.31	0.17	0.23	-0.06	0.64	0.98	-0.34	0.17	0.23	-0.06	0.65	0.98	-0.33	0.16	0.23	-0.07
24	0.45	0.58	-0.13	0.10	0.11	-0.01	0.49	0.12	0.37	0.10	0.13	-0.03	0.70	0.09	0.61	0.17	0.13	0.04
25	0.73	0.58	0.16	0.14	0.16	-0.02	0.71	0.65	0.06	0.14	0.16	-0.02	0.71	0.64	0.07	0.11	0.16	-0.05
26	0.80	0.85	-0.05	0.23	0.21	0.03	0.87	-0.22	1.09	0.24	0.29	-0.05	0.30	-0.25	0.55	0.14	0.30	-0.16
27	0.81	0.07	0.74	0.17	0.13	0.04	0.51	0.81	-0.30	0.18	0.16	0.02	0.74	0.46	0.28	0.25	0.15	0.10
28	1.39	1.65	-0.25	0.34	0.40	-0.06	2.04	2.10	-0.07	0.35	0.41	-0.06	1.84	2.20	-0.36	0.18	0.41	-0.23
29	0.74	1.42	-0.68	0.30	0.17	0.13	1.12	1.63	-0.52	0.31	0.17	0.14	1.17	1.50	-0.33	0.36	0.17	0.19
30	0.74	0.72	0.02	0.21	0.15	0.05	0.65	0.57	0.08	0.21	0.16	0.05	0.66	0.57	0.09	0.31	0.16	0.15
31	0.68	1.11	-0.43	0.20	0.28	-0.08	0.55	0.61	-0.06	0.21	0.33	-0.12	0.01	0.00	0.00	0.21	0.34	-0.13
32	0.52	0.98	-0.46	0.19	0.26	-0.07	0.52	1.07	-0.55	0.20	0.26	-0.07	0.50	1.24	-0.74	0.22	0.27	-0.05
33	0.53	0.60	-0.07	0.15	0.13	0.02	0.68	0.50	0.18	0.15	0.13	0.02	0.57	0.22	0.35	0.20	0.13	0.06
34	0.70	0.59	0.11	0.17	0.14	0.03	0.90	0.55	0.35	0.17	0.14	0.03	0.87	0.55	0.32	0.15	0.14	0.01
35	0.92	1.13	-0.21	0.22	0.30	-0.08	1.03	0.88	0.15	0.22	0.31	-0.10	1.03	0.87	0.16	0.17	0.31	-0.14
36	0.85	0.96	-0.11	0.27	0.31	-0.03	0.84	1.42	-0.58	0.27	0.32	-0.05	0.84	1.04	-0.20	0.22	0.31	-0.09
37	0.66	0.47	0.19	0.19	0.18	0.00	0.94	0.94	0.00	0.19	0.19	-0.01	0.94	0.92	0.02	0.27	0.19	0.08
38	1.16	1.40	-0.24	0.23	0.34	-0.11	2.18	1.48	0.70	0.27	0.37	-0.10	2.06	1.50	0.56	0.19	0.37	-0.18
39	0.69	0.81	-0.13	0.20	0.25	-0.05	0.52	0.72	-0.20	0.21	0.25	-0.05	0.50	0.75	-0.25	0.26	0.26	0.01

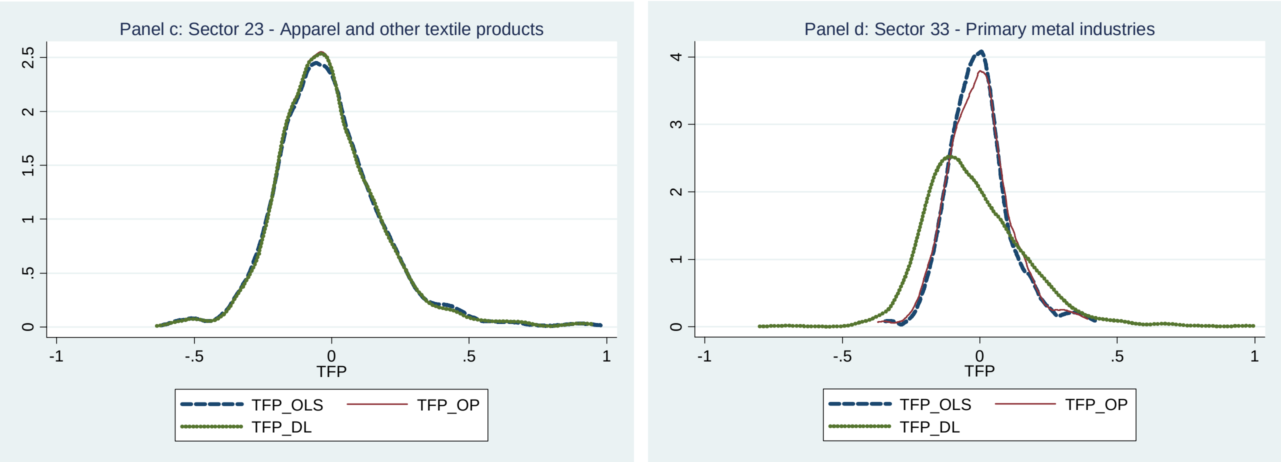
Note: TFP is calculated as a residual: $\ln TFP_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_k k_{it}$, where $\hat{\beta}_h$ (with $h = l, m, k$) stands for the estimators of the respective inputs using the different approaches discussed in Chapter 5.

Appendix F.5: Kernel density functions of *TFP*

Domestic plants



Sino-foreign joint-ventures



Note: The graphs represent the kernel density functions of the standardized *TFP*-levels for domestic plants versus Sino-foreign joint-ventures. We subtract the sector mean to standardize the TFP-levels around zero, and use cut-off levels at -1 and 1. This improves the visibility of the comparison between methodologies. The density functions are based on 484 domestic plants and 334 JVs in sector 23 - 939 domestic plants in sector 28 - 125 JVs in sector 33.