FDI and Technology Spillovers in China

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Abstract:

Using a database of Chinese firms, we examine the effects of technology spillovers not only between foreign entrants and local firms but also between "modernized" local firms to other local firms. Our results show that the increased presence of foreign multinationals within industries and in their upstream sectors positively affected the productivity of local firms. The positive intra-industry spillover effect from wholly owned subsidiaries becomes evident when the Chinese government's restriction on foreign ownership was lifted. We also find strong spillover effects among local firms.

Keywords: *foreign direct investment, spillover effects, China*

JEL classification: F2, O2

Promoting FDI has always been a primary concern for policy makers, especially in developing countries. FDI is expected to force local firms to improve their technical efficiency, and local firms can benefit from technology spillovers from foreign entrants. The Chinese government, for instance, has encouraged FDI in order to prop up backward industries. A large literature on the host country effects of FDI has been borne out of such policy concerns. Previous literature on spillovers mainly examined the relationship between the productivity of domestic firms and share of foreign-owned subsidiaries in each industry. Most of earlier industry-level studies, using cross-section data (e.g. Caves, 1974; Blömstrom, 1986), have confirmed presence of positive spillovers from FDI.

Yet the empirical findings on spillover effects are mixed. Some studies have provided evidence for positive spillover effects (Hejazi and Safarian, 1999; Javorcik, 2004; Keller, 2002; Liu, Siler, Wang, and Wei, 2000). Others have indicated the opposite (Aitken and Harrison, 1999; Konings, 2001), or found spillover effects to be confined to other multinationals (Feinberg and Majumdar, 2001). Moreover, some contend that foreign firms constitute a sufficient competitive threat that they might dampen profit margins of local firms and eventually "crowd out" them (Blomstrom, Kokko, and Zejan, 2000; Caves, 1996; De Backer and Sleuwaegen, 2003).

A seminal work by Aitken and Harrison (1999) rebut the previous industry-level studies pointing out that previous works are flawed with serious identification problem: FDI gravitates towards more productive industries, and then the observed positive correlation will overstate the positive impact of FDI.[1] Controlling for "fixed" differences in productivity levels across industries using a plant-level panel data on over 4,000 Venezuelan firms, Aitken and Harrison (1999) find that foreign equity participation is positively correlated with

[1] Regarding the identification problem, positive spillovers in previous industry-level studies may result from the fact that FDI forces the exit of less productive domestic firms, and that the market share of multinational firms who are, on average, more productive increases.

plant productivity (the "own-plant" effect), but this relation is only robust for small firms. However, since the share of foreign firms in certain industry negatively affects the productivity of wholly domestically owned plants in the same industry, the net impact of FDI, taking into account these two offsetting effects, is quite small. Konings (2001), again with firm-level data, found that FDI had a negative impact on local firms' productivity in Bulgaria and Romania.

Later, Keller and Yeaple (2004) find positive spillovers to U.S. manufacturing firms via not only FDI but also via imports even after controlling for the industry fixed effect. They argue that the positive spillovers in their studies result from (i) using better data (especially measurement of FDI); (ii) using samples mostly comprising of high-technology firms; and (iii) improvement in estimating total factor productivity (TFP) by using the Olley-Pakes method. They conjecture that their results are likely to generalize to other countries and periods. Another study using the plant-level data from UK by Haskel, Pereira and Slaughter (2004) also find a significantly positive correlation between a domestic plant's TFP and the foreign-affiliate share of activity in that plant's industry. These results suggest that absorptive capacity of host country is necessary for positive spillovers from FDI since these two studies show evidences from developed countries while negative evidences from Aitken and Harrison (1999) are from developing country.

In this paper, we build upon the FDI spillover literature and expand it by considering the spillover effects among local firms in addition to the spillover effects from foreign entrants to local firms. This study is based on panel data for more than 200,000 firms in China from 1998 to 2005. China is the world's largest emerging market, and has recently been the world's largest recipient of FDI. During 1998-2005, there were substantial changes in the composition of local firms and in the ownership structure of foreign firms. Our empirical findings provide a more complete picture of the spillovers by exploring the

dynamic changes in the composition of both foreign and local firms.

FDI and spillover revisited

While there exists a large literature on the spillover effects of MNEs, scholars have not paid a due attention toward particular channels through which spillover takes place. As argued by Aitken and Harrison (1999), there are a number of channels through which FDI affects productivity of domestic firms. First, spillovers through demonstration effect take place when a local firm improves its productivity by simply observing nearby foreign firms and copying some technology used by MNE affiliates (Blomström and Kokko, 1996). Multinationals' sheer presence in the domestic markets and the resultant exposure to foreign products/technologies can inspire local firms and stimulate them to develop new products and processes. This not only helps shorten the trial-and-error process of local firms in their search for inventions but also lower the perceived risk of innovating along similar directions for local firms since the products and technologies that multinationals bring in have already been tested in foreign markets.

Second, another type of spillovers is the one that function through competition between multinationals and local firms. The competition effect, unlike demonstration effect which is presumably positive, can be either positive or negative. FDI may toughen the competition faced by domestic firms, thereby forcing them to trim their fat and become more competitive. On the other hand, increase competition with inward FDI can also reduce productivity of domestically owned firms, particularly in the short run (Aitken and Harrison, 1999). If imperfectly competitive firms have to incur fixed costs of production, a foreign firm with lower marginal costs will have an incentive to increase production relative to its domestic competitor. In this environment, entering foreign firms producing for the local market can steal demand from domestic firms, forcing them to reduce production. As

domestic firms spread their fixed costs over a smaller market, their productivity would fall. Sembenelli and Siotis (2002) attempt to disentangle the effects from an increase in the degree of competition due to FDI. They find that FDI has a positive long-run effect on the profitability from positive spillover, while too severe competition might dampen profits margin of domestic firms in the short run. They also find that the positive spillover effects (from technology transfer) outweigh the negative effects from severe competition only in R&D intensive industries. Similarly, Chung, Mitchell, and Yeung (2003) find that direct investment by Japanese auto plants in the US increased the competitive pressures of their local suppliers and improved their productivity. They found little evidence of direct technology transfer.

Third, productivity spillovers may also occur due to labor turnover, by which former employees of multinational firms set up their own businesses and adopt some of the techniques they were using in the foreign firm (Fosfuri, et al., 2001; Song, et al., 2001). Görg and Strobl (2005) pursue empirical research along this line by examining spillovers from labor movement. They show that firms which are run by owners that worked for MNEs in the same industry immediately prior to opening up their own firm have higher productivity growth than other firms. Moreover, if at least some of the knowledge particular to foreign affiliates is embodied in their labor force, then as affiliate employees leave to work for domestic firms, this knowledge which need not be firm-specific (e.g., inventory-control or management techniques) may move as well.

Full versus partial ownership

Recent studies of spillovers from FDI suggest that the degree of foreign ownership is an important factor that influences technology diffusion in host countries (Blomström and Sjöholm, 1999; Dimelis and Louri, 2002). There exist several reasons why we expect that the higher the degree of foreign ownership share in investment projects, the more sophisticated

and efficient technologies would be transferred from the parent firm, which can create the larger scope for spillovers from FDI. First, the degree of foreign ownership is likely to influence the incentive of parent firms to transfer intangible assets such as technology and management skills to their affiliates. A fully owned affiliate would be most efficient, since the parent firm would have no inhibition to transfer its cutting-edge technology to it. By contrast, the parent firm would be less willing to transfer efficient technology to a partially owned affiliate due to the possibility of misappropriation of its knowledge-based assets by the local partner. Moreover, majority foreign ownership results in greater control over profits, which in turn provides a greater incentive to transfer technology and management skills to subsidiaries.

Yet, there are also reasons why productivity spillovers for the local economy could be stronger when foreign firms are in minority positions. First, closer contact between foreign technology and local skills in minority owned firms might facilitate the transfer of technology that is most suitable in the host country environment and thus results in faster diffusion. Moreover, local partners' better knowledge of local conditions regarding factor endowments and skill of employees would affect the choice of technology brought in by the multinationals and thereby the degree of spillovers since technologies suitable for local conditions will have the largest effect on local firms. At the same time, the higher the control of the local partners is, the more difficult it will be difficult to monitor their actions. As a consequence, it might be easier to appropriate the multinationals' proprietary knowledge which has public good properties

Indeed, empirical findings are mixed. Using the Indonesian data for 1991, Blomström and Sjöholm (1999) find that the degree of foreign ownership does neither affect the level of labor productivity in foreign establishments, nor the degree of spillovers. On the other hand, Dimelis and Louri (2002) find with a sample of manufacturing firms in Greece that a positive effect of foreign ownership on labor productivity stems from exclusively from full and

majority owned affiliates. They also find that productivity spillovers benefiting local firms are also differentiated, with minority foreign holdings exercising a stronger effect especially for the local firms with lower productivity.

Horizontal versus vertical spillovers

While the spillovers from inward FDI we considered so far are intra-industry (horizontal), many scholars recently have put a special emphasis on inter-industry (vertical) spillovers (Rodriguez-Clare, 1996; Markusen and Venables, 1999; Javorcik, 2004; Kugler, 2005; Blalock and Gertler, 2007). Vertical spillovers flow in two directions of suppliers and customers (i.e., backward and forward linkages, respectively) of the firm in consideration. Javorcik (2004) argues that spillovers through backward linkages (contacts between multinationals and their local suppliers) may take place due to (i) direct knowledge transfer from foreign customers to local suppliers; (ii) higher requirements for product quality and on-time delivery which confer incentives on domestic suppliers to upgrade their production management or technology; and (iii) increased demand for intermediate products, which allows local suppliers to reap the benefits of scale economies. Similarly, forward linkages refer to the degree to which foreign multinationals are present in the upstream sectors, supplying parts and intermediate goods, to local firms. She further contends that spillovers from FDI are more likely to be vertical than horizontal in nature since multinationals have an incentive to prevent information leakage that would enhance the performance of their local competitors, but at the same time may benefit from transferring knowledge to their local suppliers.

Indeed, evidences of spillovers of FDI through backward linkages abound. Using a firm-level panel data set from Lithuania, Javorcik (2004) finds that positive vertical spillovers from FDI take place through backward linkages. As was the case with the earlier firm-level studies of developing countries, no evidence of intra-industry spillovers is found. Blalock and

Gertler (2007) establish and quantify the welfare enhancing externalities of vertical technology transfer from multinationals to local suppliers in Indonesia. Kugler (2005) performs estimations based on the Colombian Manufacturing Census, which reveals that both technological and linkage externalities from FDI arises between but not within industries.

Absorptive capacity of local firms

A critical omission in the current spillover literature is the unilateral treatment of local firms as undifferentiated recipients of technology spillovers. So far the differing effects of FDI on local firms have mainly been discussed as a result of geographic spacing (Audretsch and Feldman, 1996; Keller, 2002) and the technology intensity of industries (Cantwell, 1989; Haddad and Harrison, 1993; Kokko, 1994; Kokko et al., 1996). Yet, there are large inter-firm variations among local firms in terms of organizational, financial, and human resources. Some local firms have developed transferable assets by restructuring, innovating, and internationalizing, and they employ these assets to learn from and compete with foreign entrants (Dawar and Frost, 1999; Zeng and Williamson, 2003).

While firms are under great conformity pressures due to tough competition in developed countries, there can be a large variance in firm productivity among local firms in many emerging markets. For example, in China, large inefficient state owned enterprises may continue operating along with nimble privately owned local firms. Thus, local firms in emerging markets may benefit from the presence of FDI to varying degrees, according to their efficiency level and to their absorptive capacity. Some "fast learners", such as the ones that emulate foreign firms in their strategy and structure, are likely to absorb foreign technology quicker and more completely than conventional firms do since the former has been born in a more competitive market, and is more responsive to environmental changes than the latter. Those "modernized" or "restructured" local firms, in turn, can serve as a medium of technology spillover: they may absorb technology from foreign firms, and then

transfer it to other local firms. Thus, the channel of spillovers can be indirect, from foreign firms to some modernized local firms, and from modernized local firms to conventional local firms. Conventional local firms can learn from these fast learners more efficiently, through various social networks among local firms, than they can do possibly from foreign firms.

Further, in prior studies, with few exceptions, local firms are assumed to have no impact on foreign entrants. Two studies that did report a "reverse spillover" effect on foreign entrants are both based on British samples: Driffield and Munday (2000) found that the labor productivity of domestic industries had a positive impact on foreign firms; Liu et al. (2000) found that the level of FDI was positively influenced by the comparative advantages of domestic industries. Moreover, some local firms may possess useful knowledge that can benefit foreign entrants. Although it is reasonable to assume that foreign entrants to an emerging market generally enjoy a technology advantage over local firms, some local firms may serve as a source of local knowledge for foreign firms, by forming joint ventures with new entrants and providing a pool of market-oriented managers and workers. Thus, foreign firms may also benefit from the presence of "modernized" or "restructured" local firms.

Empirical Models

FDI in China

China is the empirical context for this study. It is an ideal location to examine spillovers from foreign direct investments. First, it has recently changed from a Communist economic regime to a more liberalized market economy. As a consequence, there are many local firms with varying degrees of capabilities. Second, the Chinese government has encouraged FDI in order to prop up backward industries. There are numerous multinationals that operate in a full range of industries in China. Third, the Chinese government encouraged foreign multinationals to form joint ventures with local firms as a way to transfer technology.

Such a requirement of involuntary joint ventures was faded out as China prepared itself to join the World Trade Organization. Thus, China provides an interesting setting whether technology transfer would be greater under the joint venture regime or under the regime when wholly owned subsidiaries were allowed.

The economic landscape of China started to undergo major changes following the end of the Maoist "Cultural Revolution" in the late 1970s. Two major policy initiatives were taken at the end of the 1970s: the "Open Door" policy and the "Reform" policy. The "Open Door" policy refers to the invitation of inward foreign direct investments to China. In 1980s, four "Special Economic Zones" (SEZs) were established in the Southeastern coastal areas, followed by the opening of fourteen other coastal cities in 1985. During this period, the most popular form of FDI was partially foreign owned joint venture due to both governmental restrictions and the practical need for collaboration with a local partner in a largely untapped host market.

The inflow of FDI was briefly interrupted by the Tiananmen Square event in 1989. It resumed in 1992 and picked up its pace in the mid 1990s, this time centering Eastern China and spreading to the rest of the country. In the process, more and more new FDI entries started to take the form of wholly owned subsidiary as the government removed restrictions in many industries, and as multinationals accumulated experiences in the Chinese market (Vanhonacker, 1997). With China's accession to the World Trade Organization in December, 2001, most such restrictions were lifted. In 2003, China replaced the United States to become the largest recipient of FDI in the world.

The "Reform" policy refers to the transformation of China's non-market oriented state-owned sector to modern organizational forms. The reform began with incentive alignment experiments in state-owned and collectively owned enterprises in the late 1970s and the 1980s. In the mid-1990s, the Communist government decided to build a "socialist

market economy" by forming a modern corporate system. Reformed SOEs and newly established modern firms were incorporated as shareholder or limited liability firms under the new Company Law. In the mean time, another type of new firm, private firms, also proliferated. Unlike the incorporated firms, which may or may not involve some public ownership, private firms lacked political legitimacy in a society heavily influenced by the Communist ideological tradition. Despite their popularity among private entrepreneurs and their (otherwise) economic vitality, their growth was largely depressed for political reasons until 1997, when the ruling Communist Party legitimized this ownership form and claimed it to be integral to the "socialist market economy" in the Party's Fifteenth Congress (ADB report). Since then, the number of "incorporated firms" grew rapidly. These include corporati zed SOEs and firms incorporated since the beginning of the reform, which together with private enterprises represent the restructured and "modernized" Chinese firms.

Data and Sample

The data used in this study are from the annual census surveys of firms conducted by the Chinese National Bureau of Statistics. Before 1998, the surveys targeted all medium and large Chinese firms, administratively defined (namely firms designated to the township level or above). Because private firms do not have an associated administrative rank (they had no political/legal status at that time), they were not included in these annual surveys. Since 1998, the surveys have covered 1) all SOEs, and 2) all non-SOEs, including foreign firms in China and domestic private firms, with annual sales of at least RMB 5 million (roughly, $600,000 US, according to the official 2005 exchange rate) in the previous year. This new criterion reflects the government's acceptance of private firms as an important component of the Chinese economy.

Chow (1993) confirmed that the NBS statistics are largely accurate and internally consistent for empirical analysis. For this study, we assembled an eight-year panel (1998-

2005) by matching yearly data with a unique company ID number, company name, and other demographic information contained in the database. There were many cases in which the same firms with exactly the same names and the same addresses had different firm identifiers in different years because significant changes in ownership, such as joint ventures and mergers and acquisitions, occurred. We therefore developed a detailed software algorithm to assess whether firms' demographic information matched with the same firms' observations across years. For each year, 13-22% of the sample firms exited the database due to closure or acquisitions, and 14-25% of the firms that appeared in the database were new.[2] The number of local firms included in this panel ranged from 123,634 to 196,844, while the number of foreign firms ranged from 26,113 to 56,663. In order to measure the vertical linkages, we also incorporated the 2002 input-output table from the NBS to calculate the vertical linkage variables.

Figure 1 and Figure 2 show some clear trends in the composition of local firms and foreign firms in our sample. Figure 1 shows the percentages of various types of foreign firms by foreign ownership level. In 1998, the ratio of wholly owned operations to joint ventures, including majority, equal, and minority ownership, was roughly 40 to 60. Wholly owned foreign firms have since increased steadily. By 2005, the ratio has been reversed. Figure 2, on the other hand, depicts the percentage of various types of domestic firms by ownership category. In 1998, the combined modern sector—incorporated firms and private firms—constituted less than 20 percent of all firms, while the combined traditional sector—SOEs and collectives—accounted for over 80 percent. By 2005, the ratio was also reversed, with private firms being the largest winner and accounting for just above 60 percent of the total numbers. We believe that these drastic changes in the composition of local firms and the ownership

[2] The percentages of firms entered or exited were based on 1998-2003. Between 2003 and 2004, the number of firms in the annual survey increased sharply due to the Chinese government's effort to identify potential tax payers. As a consequence, 127,738 firms were added in 2004.

structure of foreign firms provide an ideal setting to examine various contingent factors to observe spillover effects.

Insert Figure 1 and 2 over here

Methodology

To investigate the impact of foreign presence in the same industry or upstream (downstream) sectors on productivity of local firms, we estimate variations of the following basic econometric equation:

$$\ln Y_{it} = a + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \beta_4 FS_{it} + \beta_5 Horizontal_{jt} + \beta_6 Backward_{jt} + \beta_7 Forward_{jt} + e_{ijrt}$$

Y_{it} stands for firm i's real output at time t, which is the adjusted reported sales, deflated by the price index. K_{it}, capital, is defined as the value of fixed assets at the beginning of the year, deflated by the average of the deflators. L_{it}, employment, is measured by the number of employees at time t. M_{it}, material inputs, are equal to the value of material inputs adjusted for changes in material inventories, deflated by material inputs deflator calculated for each sector. FS_{it} measures the share of foreign capital in firm's total capital. $Horizontal_{jt}$ denotes the extent of foreign presence in the sector and is defined as foreign equity participation averaged over all firms in the sector, weighted by each firm's share in sectoral output, and, it is measured as follows:

$$Horizontal_{jt} = [\sum_{i \text{ for all } i \in j} FS_{ijt} * Y_{ijt}] / \sum_{i \text{ for all } i \in j} Y_{ijt}$$

The variable $Backward_{jt}$ is a proxy for the foreign presence in the industries that are being supplied by the sector to which the firm in question belongs and thus is intended to capture the extent of potential contacts between domestic suppliers and multinational

customers. It is defined in the following way:

$$\text{Backward}_{jt} = \sum_{k \text{ if } k \neq j} \alpha_{jk} \text{Horizontal}_{kt}$$

where α_{jk} is the proportion of sector j output supplied to sector k.

The Forward_{jt} variable is defined as the weighted share of output in upstream (or supplying) sectors produced by firms with foreign capital participation. Following Javorcik (2004), we exclude goods produced by foreign affiliates for exports (X_{it}) as only intermediates goods sold in the domestic market are relevant to this study. The Forward_{jt} variable is constructed in the following way:

$$\text{Forward}_{jt} = \sum_{m \text{ if } m \neq j} \sigma_{jm} \left[\left[\sum_{i \text{ for all } i \in j} FS_{it} * (Y_{it} - X_{it}) \right] / \left[\sum_{i \text{ for all } i \in j} (Y_{it} - X_{it}) \right] \right]$$

where σ_{jm} is the share of inputs purchased by industry j from industry m in total inputs sourced by sector j. For the same reason as before, inputs purchased within the sector are excluded.

Scholars have raised several estimation issues regarding the basic specification. As pointed out by Haskel et al. (2002), unobserved variables are omitted in the basic specification. There are likely to be a number of firm, time and region-specific factors unknown to econometrician but known to the firm which may influence the correlation between firm productivity and foreign presence. Examples of these variables include high quality management in a particular firm or sound infrastructure present in a given region. To address this omitted-variable problem, we follow Haskel et al. (2002)'s strategy by using time differencing.[3] Of course, the cost of using the time differencing is to lose observations that do not show up for two consecutive years. We also include full sets of year, region and

[3] In addition to removing any fixed plant-specific unobservable variation, differencing will also remove fixed regional and industrial effects such as infrastructure and technological opportunity. Time, industry and regional fixed effects on the other hand will control for unobservables that may be driving changes in, for instance, attractiveness of a particular region or industry.

industry fixed effects (α_t, α_r, and α_j) to control for unobservables that may be driving changes in key variables.

It is important to note that introducing differencing and fixed effects are not enough to remove the omitted variable bias completely, if there are important unobservables that vary both across plants and over time. Without measures of these plant-and-time-varying factors such as managerial talent, estimated productivity may still be biased. Olley and Pakes (1996) argue that these remaining unobservable shocks can be proxied from investment behavior, on the assumption that it takes time to make investment and that these shocks influence current investment but not current output.

There exist two other important rationales for using the Olley-Pakes approach. It has been argued that the use of ordinary least squares may be inappropriate when estimating productivity since this method treats labor and other inputs as exogenous variables. Griliches and Mairesse (1995) have argued that inputs should be considered endogenous since firm chooses them based on its productivity, which is observed by the firm but not by the econometrician. Not taking into account the endogeneity of input choices may bias the estimated coefficients. Second, the ordinary least square method does not consider the firms' exit decisions. As a consequence, the results are subject to surviving firm bias. Given that entry and exit are so pervasive in emerging markets such as China, the explicit consideration of firms' exit activities, available in the Olley-Pakes estimation procedure, can be crucial.

In a variant of the above basic econometric equation, we calculate two separate horizontal variables, $\Delta\text{Horizontal\_Partial}_{jt}$ and $\Delta\text{Horizontal\_Wholly}_{jt}$: one for partially and one for fully-owned foreign projects. This is to study how the degree of foreign ownership affects spillovers from FDI. Recent paper by Javorcik and Spatareanu (2004b) argue that the

ownership structure of FDI may affect the presence of horizontal spillovers in two ways. First, fear of technology leakage, especially in countries with limited rule of law, may induce firms with most sophisticated technologies to shy away from shared ownership and instead choose to invest only in wholly-owned projects. Second, it is generally believed by policy makers in developing countries that participation of local capital in a foreign investment project reveals the multinational's proprietary technology and thus facilitates spillovers. The overall relationship between the share of foreign ownership and spillovers is the result of these two forces and its sign is, therefore, ambiguous. Javorcik and Spatareanu (2004b) find that the degree of foreign ownership matters for intra as well as for inter-industry spillovers from FDI. They find that positive horizontal spillovers are linked to wholly-owned but not to partially-owned foreign projects. They also find that the pattern of vertical spillovers is also consistent with their expectations. The results point to positive externalities being associated with partially-owned foreign projects which are hypothesized to rely more heavily on local suppliers. On the other hand, wholly-owned foreign subsidiaries appear to have a negative effect on the productivity of domestic firms in upstream sectors

Our paper has made a number of major differences from Javorcik and Spatareanu (2004b). First, we have added three variables, $\Delta\text{Horizontal\_Local}_{jt}$, $\Delta\text{Backward\_Local}_{jt}$, and $\Delta\text{Forward\_Local}_{jt}$ which reflect the presence of "modernized" local firms within the same industries and vertical chains, just as we measure foreign firms' presence. Our conjecture is that productivity spillovers may arise from the presence of not only multinationals but also modernized local firms that have superior absorptive capacity. Second, we include firm-type dummy variables ($\gamma_p, \gamma_i, \gamma_c,$ and γ_f) to examine whether the firm-type matters for the spillover effects. We classify all firms in our sample into five firm-types: state owned enterprises, private firms, incorporated firms, collectives, and foreign firms, where

state owned enterprises serve as a reference group.

In light of both omitted-variables and endogeneity issues, we estimate versions of the following differenced equation employing the semiparametric estimation procedure suggested by Olley and Pakes (1996). [4]

$$\begin{aligned}\Delta \ln Y_{it} = {} & \delta_1 \Delta \ln K_{it} + \delta_2 \Delta \ln L_{it} + \delta_3 \Delta \ln M_{it} + \delta_4 \Delta FS_{it} + \delta_5 \Delta \text{Horizontal\_Partial}_{jt} \\ & + \delta_6 \Delta \text{Horizontal\_Wholly}_{jt} + \delta_7 \Delta \text{Backward}_{jt} + \delta_8 \Delta \text{Forward}_{jt} \\ & + \delta_9 \Delta \text{Horizontal\_Local}_{jt} + \delta_{10} \Delta \text{Backward\_Local}_{jt} + \delta_{11} \Delta \text{Forward\_Local}_{jt} \\ & + \gamma_p + \gamma_i + \gamma_c + \gamma_f + \alpha_t + \alpha_r + \alpha_j + e_{ijrt}\end{aligned}$$

Results

Table 1 shows the descriptive statistics, and tables 2 and 3 show results only for local firms, using the first difference in output and the first difference in total factor productivity by the Olley-Pakes method, respectively. The descriptive statistics in Table 1 suggest that backward linkages variable of foreign firms' presence and backward linkages variable of modernized local firms' presence have a high level of correlations (0.62). In both tables 2 and 3, we incorporate modernized local firms' presence variables sequentially to detect any changes in sign when new set of variables are added.

Insert Table 1, 2 and 3 over here

The intra-industry foreign firms' presence variable is positively signed and significant in model (1) of table 2, suggesting positive horizontal spillovers from foreign firms to local firms. In model (2), we separate the intra-industry foreign firms' presence into two-- that of wholly owned foreign firms and that of partially owned foreign firms. The observed positive horizontal spillover effects in model (1) seem to come from partially owned foreign subsidiaries than from wholly owned subsidiaries. As for possible spillover effects from

[4] The details of the procedure are described in the Appendix.

foreign firms' presence in the vertically related industries, forward linkages, i.e., foreign multinationals' participations in upstream sectors such as supplying parts and intermediate goods to local firms, have a positively significant impact on local firms' productivity. In other words, foreign multinationals' direct participation in parts and components manufacturing has positive spillover effects to downstream sectors since they might have transferred key technologies in improving quality and overall performance of important components. On the other hand, the backward linkages, i.e., multinationals' presence in the downstream industries, do not have any significant impact on local firms' productivity.

Models (3) and (4) incorporate three additional variables reflecting the presence of modernized local firms within industries, and in industries that are vertically related. In models (3) and (4), all three variables turn out to be positively significant, suggesting that the higher the shares of modernized local firms (i.e., private firms and incorporated firms) in the same industries or in vertically related industries are, the higher the productivity levels of local firms are. Foreign firms' backward linkage variable, which is insignificant in models (1) and (2), turns negatively signed and significant in models (3) and (4), which seem to be driven by high correlation with modernized local firms' backward linkage variable (0.62).

In models (5)-(8), we divide sample into two time periods, i.e., 1998-2001, and 2002-2005. With China's accession to the World Trade Organization in December 2001, most restrictions on setting up wholly owned subsidiaries were lifted. Figure 1 clearly shows a trend of sharp increase of wholly owned foreign subsidiaries at the expense of partially owned ones. The presence of partially owned foreign firms is turned out to be significant, albeit weakly, in period 1, while the presence of wholly owned subsidiary and the foreign firm's presence in the vertically related sectors have no impact on local firms' productivity. The backward linkage of modernized local firms to other local firms is also weakly positive, suggesting some vertical spillovers among local firms. In period 2, however, horizontal

spillovers from both wholly owned and partially owned subsidiaries turn out to be positively significant. The forward spillovers from foreign to local firms are also positively significant in period 2. All three spillover variables from modernized local firms to other local firms turn out to be positively significant, suggesting a strong evidence of spillover effects among local firms.

Table 3 shows results from the Olley-Pakes regressions, where the difference in total factor productivity between time t-1 and t is the dependent variable. The results are quite comparable to ones in table 2. The presence of partially owned foreign firms has weakly positive impact on local firms' productivity in period 1, while both wholly owned and partially owned foreign firms are strongly positive in period 2. Unlike models in table 2, forward linkages of foreign firms turn insignificant in all models in table 3. Spillover effects from modernized local firms are positively significant only in period 2.

Table 4 and 5 shows results using both foreign and local firms. We have added the foreign firms' ownership share variable to examine whether the increased foreign ownership in a firm improves its productivity. The results in table 4 suggest that the increased foreign ownership, e.g., from partially owned to wholly owned subsidiaries, improves the firm productivity, especially in period 2, reflecting that foreign multinationals are more willing to transfer advanced technology when they can ensure control over the subsidiaries. The foreign firm share variable is not significant in models in table 5, using the difference in total factor productivity. Other variables show very similar patterns with those in table 2 and 3.

Regarding the firm type controls, all private firms, incorporated firms, collectives and foreign firms are more productive than state owned enterprises that serve as a reference group. Privately owned local firms seem to have the highest level of productivity compared to other types of firms.

Insert Table 4 and 5 over here

Conclusions

This study re-examines the much debated issue of possible spillover effects from foreign direct investment. Our findings differ from previous studies in three important ways. First, unlike previous firm level studies in developing countries (Aitken and Harrison, 1999; Konings, 2001), we find intra-industry strong positive spillover effects from foreign firms to local firms. Prior to 2001, such intra-industry spillover effects seem present only from partially owned foreign subsidiaries. During the period of 2002-05, when the restrictions for setting up a wholly owned subsidiary were lifted, such a positive intra-industry spillover can be also found from wholly owned subsidiaries. Yet, the size of coefficient for partially owned foreign firms is about twice the size of that for wholly owned foreign firms, suggesting that joint venture requirements by the Chinese government in fact achieved its strategic goal – transferring technology to backward local industries.

Second, unlike prior studies that found positive spillover effects from backward linkages, i.e., contact between multinational customers and local suppliers (Javorcik, 2004; Javorcik and Spartareanu, 2003), we find that the forward linkages, i.e., multinationals' direct involvement in the upstream sectors, supplying parts and intermediates goods to both foreign and local customers, are important sources for spillovers. When Volkswagen set up its joint venture with SAIC (Shanghai Automobile Investment Corporation) in 1984, it promised the government to transfer automobile manufacturing technology to Chinese part suppliers and to increase local content to 95% by 1995. As a way to achieve the required local content and to improve its performance, it urged its suppliers to form joint ventures with Chinese local firms and to transfer technology. Strangely, there was no evidence of backward linkages in China.

Third, this study might be unique in the sense that we incorporate the possible

spillover effects from “modernized” local firms to other local firms. Chinese local firms differ greatly from each other in terms of efficiency level and absorptive capacity. For instance, state owned enterprises did not have abilities or incentives to learn from foreign multinationals. We find that the larger the presence of modernized local firms within industries and in vertically related industries is, the higher the productivity of local firms is. These modernized local firms serve as a medium to absorb technology from foreign entrants and they become the sources of spillovers to other local firms.

This study employs various methodologies that overcome the limitations of prior works. The time differencing technique resolves the issues of unobserved firm heterogeneity and the employment of the Olley-Pakes semi-parametric approach resolves the issues of endogeneity and selection bias. With these methodological improvements, we can be assured of our somewhat conflicting findings to prior works that observed no horizontal spillovers in other emerging economies. We, however, believe that certainly more work is needed to improve our understanding of the relationship between FDI and spillover effects.

Appendix: The Olley-Pakes Method

We attempt to correctly measure firm productivity by drawing on the framework for dynamic industry equilibrium analysis developed by Olley and Pakes (1996). Two salient features of the Olley-Pakes method are firm-specific productivity differences that exhibit idiosyncratic changes over time and the endogenous exit rule. These features allow us to address the endogeneity problem and the selection bias which afflicted production function estimates for a long time. To illustrate the insights of the Olley-Pakes method, we start with the following production function for firm i:

$$y_i = \beta_0 + \beta_k k_i + \beta x_i + \varepsilon_i \qquad (1)$$

where y_i is gross output, k_i is capital, and x_i is a vector of variable intermediate inputs such as labor and materials. All of the above variables are in logs. Firm-specific error term, ε_i can be interpreted as technology, managerial ability, etc. The endogeneity problem arises by the fact that ε_i is known by firm but not by the econometrician when making a choice of variable inputs. That is, x_i may be correlated with ε_i.

As the first step to address the endogeneity problem, Olley and Pakes (1996) consider the dynamic setting (introduce time t) and make the following assumption on ε_{it}:

$$\varepsilon_{it} = \omega_{it} + \eta_{it} \qquad (2)$$

where ω_{it} denotes "efficiency" (firm productivity) and η_{it} is a serially uncorrelated idiosyncratic shock. Olley and Pakes (1996) assume that ω_{it} follows a first-order Markov process. That is, probability that ω_{it+1} will realize depends "only" on ω_{it}.

The key innovation of the Olley-Pakes method is to proxy for the unobservable firm-specific productivity shock ω_{it} by introducing an investment rule into the analysis. Olley and Pakes (1996) assume that capital accumulates following a deterministic rule:

$$k_{it} = (1-\delta)k_{it-1} + i_{it-1}. \quad (3)$$

where δ signifies the capital depreciation rate. Note that investment level is chosen in the "last" period, so that today's capital does not react to η_{it}, today's shock. For simplicity, we only discuss the solution to dynamic programming, a Markov Perfect Equilibrium strategy for firm's choice of exit and investment.

At the beginning of the period t, the firm learns its productivity, ω_{it}, which is assumed to evolve according to an exogenous Markov process. For a sufficiently low value of ω_{it}, a firm's value of continuing in operation will be less than some (exogenous) liquidation value, and it will exit. We denote the threshold level at which a firm is indifferent between exiting and staying by $\tilde{\omega}_t$. Thus, the optimal exit rule is:

Stay if $\omega_{it} \geq \tilde{\omega}_t$

Exit otherwise (4)

The cut-off productivity $\tilde{\omega}_t$ is assumed to be time-varying to capture the changing market structure in which the firms compete with each other. The investment rule is derived by solving the Bellman equation:

$$i_{it} = i_t(k_{it}, \omega_{it}). \quad (5)$$

The investment function is also assumed to be time-varying to reflect the changing competitive conditions that firms face in a given industry. Olley and Pakes (1996) show that under certain conditions that optimizing firms tend to have investment functions that are strictly increasing in the unobserved productivity shock, ω_{it}. Since investment is strictly monotonic in ω_{it}, we can invert the investment function to find out the efficiency ω_{it}:

$$\omega_{it} = h_t(k_{it}, i_{it}). \quad (6)$$

We take a two-stage approach for estimation. In the first stage, we estimate the following

econometric equation to obtain estimates of the coefficients on the variable inputs x_{it}:

$$\begin{aligned} y_{it} &= \beta_0 + \beta_k k_{it} + \beta x_{it} + h_t(k_{it}, i_{it}) + \eta_{it} \\ &= \beta x_{it} + \varphi_t(k_{it}, i_{it}) + \eta_{it}. \end{aligned} \quad (7)$$

The functional form of $\varphi_t(\cdot)$ is not known, and we estimate the partially linear regression model using a third-order polynomial in capital and investment to approximate the functional form of $\varphi_t(\cdot)$. Since $\varphi_t(k_{it}, i_{it})$ controls for unobserved "efficiency" ω_{it}, the error term in the production function η_{it} is no longer correlated with a firm's choice of the variable inputs x_{it}, and the estimated coefficient vector $\hat{\beta}$ is consistent.

We proceed with the second stage, where we estimate the coefficient on capital β_k. Since we have $\hat{\beta}x_{it}$, we need to estimate the following econometric equation:

$$y_{it} - \hat{\beta}x_{it} = \beta_0 + \beta_k k_{it} + \omega_{it} + \eta_{it}. \quad (8)$$

Using the Markov assumption, one can rewrite ω_{it} as an unknown function of ω_{it-1} to be estimated non-parametrically plus the innovation in ω_{it} denoted by ξ_{it} which is uncorrelated with k_{it} by definition.

$$\omega_{it} = g(\omega_{it-1}) + \xi_{it} \quad (9)$$

Since we now have an estimate of $\varphi_t = y_{it} - \beta x_{it}$, which allows us to have an estimate of $\omega_{it}(\beta_0, \beta_k) = \varphi_{it} - \beta_0 - \beta_k k_{it}$, the econometric equation becomes:

$$\begin{aligned} y_{it} - \hat{\beta}x_{it} &= \beta_0 + \beta_k k_{it} + g(\omega_{it-1}) + \xi_{it} + \eta_{it} \\ &= \beta_0 + \beta_k k_{it} + g(\varphi_{t-1} - \beta_0 - \beta_k k_{it-1}) + \xi_{it} + \eta_{it} \\ &= \beta_k k_{it} + \tilde{g}(\varphi_{t-1} - \beta_k k_{it-1}) + \xi_{it} + \eta_{it} \end{aligned} \quad (10)$$

where $\tilde{g}(\varphi_{t-1} - \beta_k k_{it-1})$ subsumes the constant term, β_0.

Yet, we still need to consider that we only observe those firms that select to stay in the industry. As we already have seen, the Olley-Pakes approach generates an exit rule, so that we can account for this self-selection and avoid the associated selection bias. Pavcnik (2002) shows that the expectation of future productivity conditional on a firm staying in the market $g(\omega_{it})$ is a function of productivity in the current period ω_{it}, and the cut-off productivity $\widetilde{\omega}_{t+1}$ in equation (4). Since we already know how to control for ω_{it}, we only need to find a way to control for $\widetilde{\omega}_{t+1}$.

We extract information about the cut-off productivity, $\widetilde{\omega}_t$ by evaluating the probability that a firm continues to operate at time t. We can model the probability of survival to period t as a function of capital and investment at time t-1 (see Pavcnik, 2002). We generate an estimate of the survival probability by running a probit regression on a third order polynomial in capital and investment (lagged by one period), and denote the estimated survival probability by $\hat{P}_t$. Thus, the final estimation step is given by estimating β_k from the following equation:

$$y_{it} - \hat{\beta} x_{it} = \beta_k k_{it} + \widetilde{g}(\varphi_{t-1} - \beta_k k_{it-1}, P_{t-1}) + \xi_{it} + \eta_{it} . \qquad (11)$$

As in Pavcnik (2002), we employ the nonlinear least squares technique, using a third-order polynomial in $\varphi_{t-1} - \beta_k k_{it-1} = \omega_{it-1}$ and $\hat{P}_{t-1}$ to control for $\widetilde{g}(\cdot)$ where

$$\widetilde{g}(\varphi_{t-1} - \beta_k k_{it-1}, P_{t-1}) = \sum_{j=0}^{3-m} \sum_{m=0}^{3} \beta_{mj} (\hat{\varphi}_{t-1} - \beta_k k_{it-1})^m \hat{P}_{t-1}^{\ j}.$$

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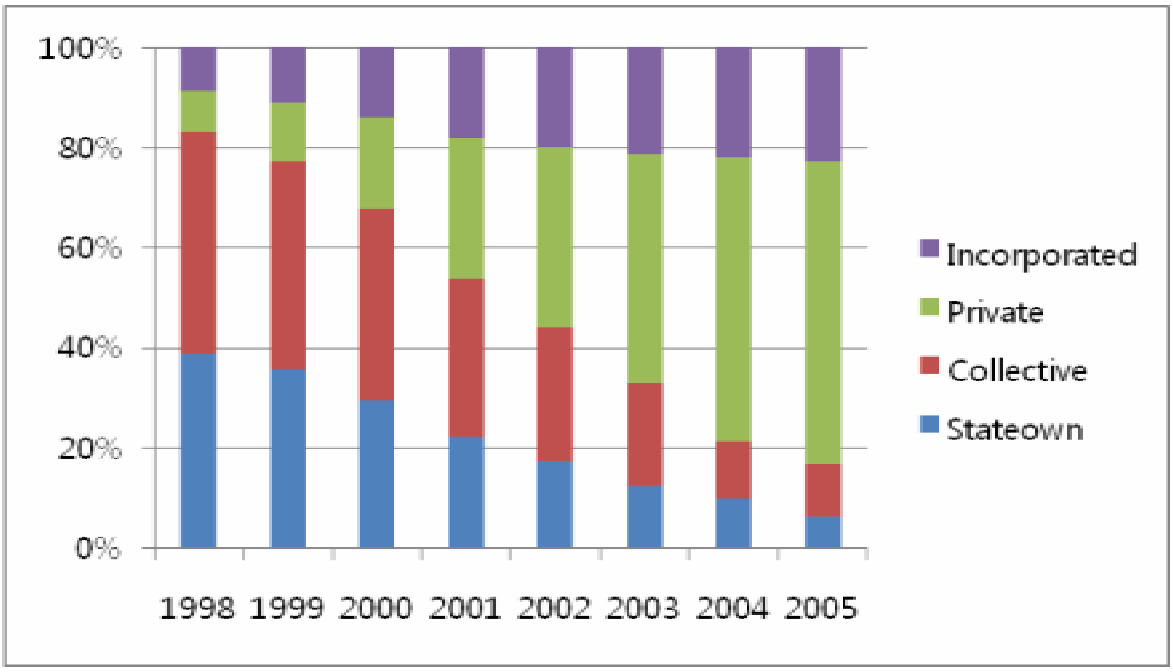
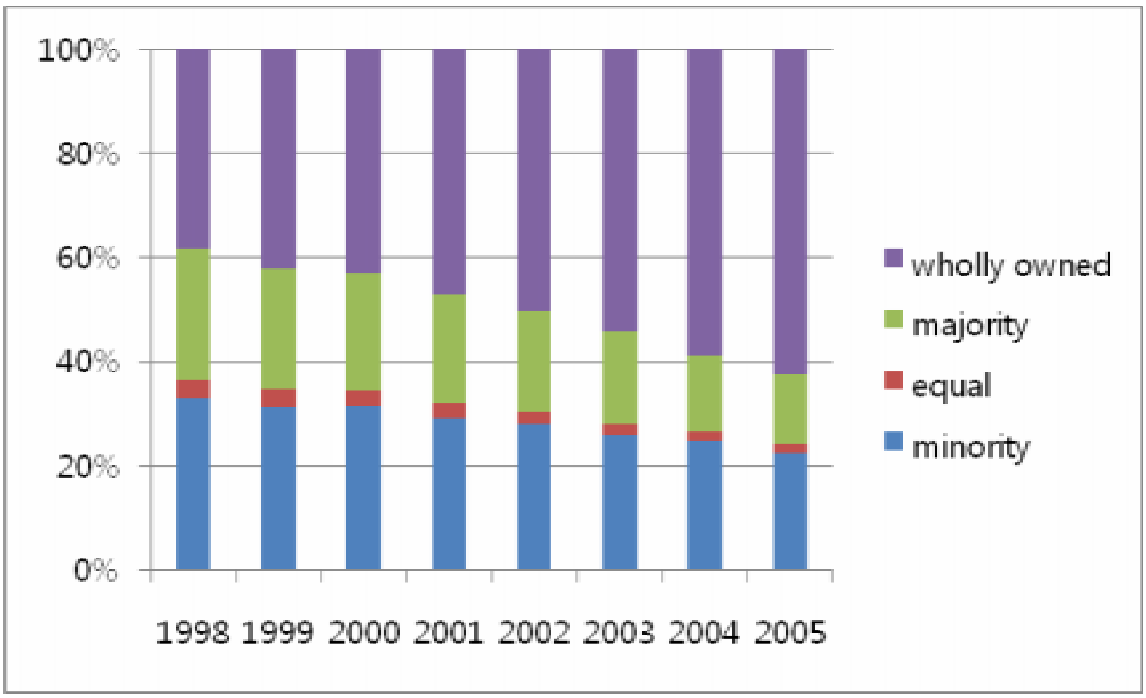
Figure 1 Composition of local firms 1998-2005



Number of firms	123,634	120,720	120,322	124,722	133,285	143,564	203,418	196,844

Figure 2 Composition of foreign firms 1998-2005



Number of firms	26,113	26,454	28,027	30,937	34,045	38,104	56,582	56,613

Table 1 Descriptive Statistics

Variable	Mean	Std.Dev.	Min	Max
(1) Δ output	0.062	0.620	-10.894	9.217
(2) Δ Labor	-0.010	0.416	-7.250	6.791
(3) Δ Material	0.059	0.625	-11.665	12.949
(4) Δ Capital	0.047	0.594	-11.785	9.445
(5) Δ Total factor productivity	0.009	0.522	-13.752	10.640
(6) Δ Foreign firm share	0.001	0.123	-6.771	6.771
(7) Δ Horizontal presence	0.003	0.062	-0.909	0.942
(8) Δ Wholly owned firms' horizontal presence	0.010	0.055	-0.934	0.898
(9) Δ Partially owned firms' horizontal presence	-0.006	0.027	-0.567	0.322
(10) Δ Forward linkages	0.001	0.034	-0.396	0.443
(11) Δ Backward linkages	0.003	0.075	-1.196	1.298
(12) Δ Modernized local firms' horizontal linkages	0.056	0.069	-0.838	0.709
(13) Δ Modernized local firms' forward linkages	0.021	0.031	-0.453	0.523
(14) Δ Modernized local firms' backward linkages	0.017	0.054	-0.666	0.598
(15) Privately owned firms	0.236	0.425	0	1.000
(16) Incorporated firms	0.167	0.373	0	1.000
(17) Collectives	0.203	0.402	0	1.000
(18) Foreign firms	0.247	0.431	0	1.000

Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.00																	
2	0.25	1.00																
3	0.59	0.22	1.00															
4	0.15	0.14	0.13	1.00														
5	0.54	0.00	-0.35	-0.01	1.00													
6	0.01	0.01	0.01	0.00	0.00	1.00												
7	0.00	-0.01	0.01	0.01	0.00	0.01	1.00											
8	0.00	0.00	0.00	0.01	0.00	0.00	0.90	1.00										
9	0.01	-0.01	0.01	0.01	0.00	0.00	0.44	0.00	1.00									
10	0.00	-0.01	-0.01	0.00	0.01	0.00	0.30	0.26	0.16	1.00								
11	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.20	0.00	-0.20	1.00							
12	0.01	-0.02	0.01	0.01	0.00	0.00	-0.47	-0.48	-0.08	-0.10	-0.11	1.00						
13	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.03	-0.06	0.05	0.01	-0.08	0.11	1.00					
14	0.01	0.00	0.00	0.00	0.00	0.00	-0.11	-0.06	-0.13	-0.23	0.62	0.14	0.02	1.00				
15	0.05	0.04	0.05	0.06	0.01	-0.01	-0.04	-0.03	-0.04	-0.04	-0.01	-0.05	-0.08	-0.02	1.00			
16	0.01	-0.01	0.01	0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.03	-0.01	-0.25	1.00		
17	-0.01	-0.02	-0.02	-0.01	0.00	-0.01	0.02	0.00	0.04	0.02	0.01	0.07	0.08	0.04	-0.28	-0.23	1.00	
18	0.01	0.05	0.01	-0.02	0.00	0.03	0.00	0.02	-0.04	0.00	0.01	-0.05	0.01	-0.02	-0.32	-0.26	-0.29	1.00

Table 2 Results from OLS Regressions in First Differences (Δ ln firm output is a dependent variable)

		Whole period				1998-2001		2002-2005	
	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Foreign firms' presence	Horizontal foreign Presence (Δ)	0.046 (0.016)**		0.171 (0.018)***		0.038 (0.052)		0.232 (0.020)***	
	Wholly owned (Δ)		0.001 (0.018)		0.139 (0.020)***		-0.017 (0.061)		0.195 (0.022)***
	Partially owned (Δ)		0.188 (0.033)***		0.263 (0.033)***		0.144 (0.083)+		0.360 (0.039)***
	Forward (Δ) linkages	0.088 (0.028)**	0.088 (0.028)**	0.079 (0.028)**	0.080 (0.028)**	0.363 (0.272)	0.392 (0.272)	0.065 (0.027)**	0.065 (0.027)*
	Backward (Δ) linkages	-0.004 (0.014)	0.002 (0.014)	-0.056 (0.018)**	-0.054 (0.018)**	-0.029 (0.069)	-0.031 (0.069)	-0.053 (0.018)**	-0.051 (0.018)**
Res-tructured local firms' presence	Horizontal modern local presence (Δ)			0.207 (0.015)***	0.200 (0.015)***	0.059 (0.041)	0.048 (0.042)	0.281 (0.017)***	0.273 (0.017)***
	Forward modern local presence(Δ)			0.129 (0.031)***	0.125 (0.031)***	0.187 (0.097)+	0.184 (0.097)+	0.139 (0.034)***	0.133 (0.034)***
	Backward modern local presence(Δ)			0.115 (0.022)***	0.121 (0.022)***	-0.031 (0.112)	-0.007 (0.113)	0.122 (0.022)***	0.128 (0.023)***
Local firms types	Private firms(Δ)	0.039 (0.002)***	0.039 (0.002)***	0.040 (0.002)***	0.040 (0.002)***	0.038 (0.005)***	0.038 (0.005)***	0.041 (0.003)***	0.041 (0.003)***
	Incorporated firms(Δ)	0.027 (0.002)***	0.027 (0.002)***	0.027 (0.002)***	0.028 (0.002)***	0.024 (0.005)***	0.024 (0.005)***	0.029 (0.003)***	0.029 (0.003)***
	Collectives (Δ)	0.026 (0.002)***	0.026 (0.002)***	0.026 (0.002)***	0.026 (0.002)***	0.022 (0.004)***	0.036 (0.004)***	0.028 (0.003)***	0.028 (0.003)***
	No. of observations	391,564	391,564	391,564	391,564	115,081	115,081	276,483	276,483
	R-squared	0.361	0.362	0.362	0.362	0.325	0.325	0.378	0.378

[Note] Δ ln labor, Δ ln capital, Δ materials, 3-digit SIC industry, area, and year fixed effects are not shown

***: P<0.001, **: p<0.01, *: p<0.05, +: p<0.10

Table 3 Results from Olley-Pakes Regressions (Δ ln total factor productivity is a dependent variable)

		Whole period				1998-2001		2002-2005	
	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Foreign firms' presence	Horizontal foreign Presence (Δ)	0.002 (0.017)		0.081 (0.020)***		0.005 (0.005)		0.093 (0.022)**	
	Wholly owned (Δ)		-0.017 (0.020)		0.066 (0.022)**		0.006 (0.064)		0.074 (0.025)**
	Partially owned(Δ)		0.064 (0.036)+		0.121 (0.036)**		0.147 (0.088)+		0.156 (0.043)**
	Forward linkages(Δ)	0.048 (0.030)	0.048 (0.030)	0.046 (0.031)	0.046 (0.031)	0.295 (0.287)	0.321 (0.290)	0.041 (0.030)	0.040 (0.030)
	Backward linkages(Δ)	0.004 (0.015)	0.007 (0.016)	-0.053 (0.020)**	-0.053 (0.020)**	-0.083 (0.074)	-0.085 (0.074)	-0.039 (0.020)+	-0.039 (0.020)+
Res-tructured local firms' presence	Horizontal modern local presence(Δ)			0.111 (0.016)***	0.108 (0.016)***	0.042 (0.044)	0.033 (0.045)	0.141 (0.019)***	0.138 (0.019)***
	Forward modern local presence(Δ)			0.068 (0.034)***	0.066 (0.034)+	-0.005 (0.103)	-0.007 (0.103)	0.090 (0.038)*	0.087 (0.038)*
	Backward modern local presence(Δ)			0.123 (0.025)***	0.126 (0.025)**	0.050 (0.122)	0.072 (0.123)	0.117 (0.025)+	0.120 (0.025)***
Local firms types	Private firms(Δ)	0.009 (0.002)***	0.009 (0.002)***	0.009 (0.002)***	0.009 (0.002)***	0.015 (0.006)***	0.015 (0.006)***	0.006 (0.003)+	0.006 (0.003)+
	Incorporated firms(Δ)	0.005 (0.003)+	0.005 (0.003)+	0.005 (0.003)+	0.005 (0.003)+	0.008 (0.005)	0.009 (0.005)	0.003 (0.003)	0.003 (0.003)
	Collectives (Δ)	0.012 (0.003)***	0.012 (0.002)***	0.012 (0.002)***	0.012 (0.002)***	0.012 (0.004)**	0.012 (0.004)**	0.010 (0.003)**	0.010 (0.003)**
	No. of observations	390,648	390,648	390,648	390,648	114,479	114,479	276,179	276,179
	R-squared	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003

[Note] 3-digit SIC industry, area, and year fixed effects are not shown

***: P<0.001, **: p<0.01, *: p<0.05, +: p<0.10

Table 4 Results from OLS Regressions in First Differences (Δ ln firm output is a dependent variable) – including both local and foreign firms

		Whole period				1998-2001		2002-2005	
	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Foreign firm Share (Δ)	0.009 (0.005)+	0.009 (0.005)+	0.009 (0.005)+	0.009 (0.005)+	-0.005 (0.012)	-0.005 (0.012)	0.014 (0.006)*	0.013 (0.006)*
Foreign firms' presence	Horizontal foreign Presence (Δ)	0.046 (0.013)**		0.171 (0.014)***		0.003 (0.040)		0.229 (0.016)***	
	Wholly owned(Δ)		0.009 (0.014)		0.142 (0.016)***		-0.003 (0.047)		0.198 (0.017)***
	Partially owned(Δ)		0.183 (0.026)***		0.264 (0.027)***		0.123 (0.067)+		0.346 (0.031)***
	Forward linkages(Δ)	0.052 (0.023)*	0.053 (0.023)*	0.042 (0.023)+	0.043 (0.023)+	0.119 (0.201)	0.137 (0.201)	0.034 (0.023)	0.035 (0.023)
	Backward linkages(Δ)	-0.005 (0.010)	0.000 (0.010)	-0.049 (0.013)**	-0.049 (0.013)**	-0.024 (0.048)	-0.028 (0.048)	-0.051 (0.014)**	-0.051 (0.014)**
Res-tructured local firms' presence	Horizontal modern local presence(Δ)			0.198 (0.012)***	0.190 (0.012)***	0.088 (0.035)*	0.079 (0.036)*	0.266 (0.014)***	0.259 (0.014)***
	Forward modern local presence(Δ)			0.126 (0.026)***	0.122 (0.026)***	0.187 (0.080)*	0.185 (0.080)*	0.140 (0.027)***	0.133 (0.027)***
	Backward modern local presence(Δ)			0.107 (0.019)***	0.114 (0.019)***	0.037 (0.092)	0.060 (0.092)	0.110 (0.019)***	0.118 (0.019)***
Firms types	Private firms(Δ)	0.042 (0.002)***	0.042 (0.002)***	0.042 (0.002)***	0.042 (0.002)***	0.041 (0.005)***	0.041 (0.005)***	0.041 (0.003)***	0.041 (0.003)***
	Incorporated firms(Δ)	0.030 (0.002)***	0.030 (0.002)***	0.030 (0.002)***	0.030 (0.002)***	0.026 (0.005)***	0.026 (0.005)***	0.030 (0.003)***	0.030 (0.003)***
	Collectives(Δ)	0.026 (0.002)***	0.027 (0.002)***	0.026 (0.002)***	0.026 (0.002)***	0.023 (0.004)***	0.023 (0.004)***	0.028 (0.003)***	0.028 (0.003)***
	Foreign firms(Δ)	0.029 (0.002)***	0.029 (0.002)***	0.029 (0.002)***	0.029 (0.002)***	0.031 (0.004)***	0.031 (0.004)***	0.027 (0.003)***	0.027 (0.003)***
	No. of observations	513,858	513,858	513,858	513,858	146,917	146,917	366,941	366,941
	R-squared	0.373	0.373	0.373	0.373	0.336	0.336	0.389	0.389

[Note] Δ ln labor, Δ ln capital, Δ materials, 3-digit SIC industry, area, and year fixed effects are not shown. ***: P<0.001, **: p<0.01, *: p<0.05, +: p<0.10

Table 5 Results from Olley-Pakes Regressions (Δ ln total factor productivity is a dependent variable) – including both local and foreign firms

		Whole period				1998-2001		2002-2005	
	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Foreign firms share (Δ)	0.003 (0.005)	0.003 (0.005)	0.003 (0.005)	0.003 (0.005)	-0.009 (0.013)	-0.009 (0.013)	0.006 (0.006)	0.006 (0.006)
Foreign firms' presence	Horizontal foreign presence(Δ)	-0.001 (0.013)		0.073 (0.015)***		0.043 (0.044)		0.089 (0.017)**	
	Wholly owned (Δ)		-0.015 (0.015)		0.061 (0.017)**		0.014 (0.049)		0.076 (0.019)***
	Partially owned(Δ)		0.057 (0.028)*		0.112 (0.029)**		0.118 (0.071)+		0.140 (0.034)***
	Forward linkages(Δ)	0.008 (0.025)	0.009 (0.025)	0.005 (0.025)	0.006 (0.025)	0.037 (0.212)	0.052 (0.212)	0.005 (0.025)	0.005 (0.025)
	Backward linkages(Δ)	0.004 (0.011)	0.006 (0.011)	-0.040 (0.014)**	-0.040 (0.014)**	-0.071 (0.051)	-0.074 (0.051)	-0.031 (0.015)*	-0.031 (0.015)*
Res-tructured local firms' presence	Horizontal modern local presence(Δ)			0.103 (0.013)**	0.100 (0.013)***	0.063 (0.037)	0.055 (0.038)	0.132 (0.015)***	0.129 (0.015)***
	Forward modern local presence(Δ)			0.073 (0.028)**	0.071 (0.028)*	0.037 (0.085)	0.036 (0.085)	0.090 (0.030)**	0.087 (0.030)**
	Backward modern local presence(Δ)			0.102 (0.020)***	0.105 (0.021)***	0.107 (0.099)	0.125 (0.100)	0.093 (0.021)***	0.096 (0.021)***
Firms types	Private firms(Δ)	0.013 (0.002)***	0.013 (0.002)***	0.013 (0.002)***	0.013 (0.002)***	0.017 (0.005)**	0.017 (0.005)**	0.009 (0.003)**	0.009 (0.003)**
	Incorporated firms(Δ)	0.009 (0.002)**	0.009 (0.002)**	0.009 (0.002)**	0.009 (0.002)**	0.011 (0.005)*	0.011 (0.005)*	0.006 (0.003)+	0.006 (0.003)+
	Collectives(Δ)	0.013 (0.003)***	0.013 (0.003)***	0.013 (0.003)***	0.013 (0.003)***	0.013 (0.004)**	0.013 (0.004)**	0.011 (0.003)**	0.011 (0.003)**
	Foreign firms(Δ)	0.007 (0.002)**	0.007 (0.002)**	0.008 (0.002)**	0.007 (0.002)**	0.012 (0.004)**	0.012 (0.004)**	0.003 (0.003)	0.003 (0.003)
	No. of observations	514,646	514,646	514,646	514,646	146,876	146,876	367,770	367,770
	R-squared	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.002

[Note] 3-digit SIC industry, area, and year fixed effects are not shown. ***: P<0.001, **: p<0.01, *: p<0.05, +: p<0.10