Corporate sector restructuring, Productivity growth and the Role of Foreign-owned enterprises in China

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This study examines the productivity consequences of two important developments, namely the large-scale restructuring of and substantial foreign direct investment inflow into China's corporate sector since the late 1990s, using firm-level data from 1998 to 2007. The ownership affiliations of a large number of manufacturing firms changed from the state to the private sector, from domestically owned to foreign owned, and from one type of foreign ownership (Hong Kong, Macao, Taiwan) to the opposite (termed the HMT and non-HMT groups, respectively) during this period. We first examine the key characteristics of firm-level total factor productivity changes and decompose the total factor productivity growth of each ownership category by using the dynamic Olley–Pakes method. Second, we estimate the productivity spillover effects of foreign-owned enterprises (FOEs), paying special attention to the role of newly acquired FOEs in the HMT and non-HMT groups. The horizontal and vertical spillover effects associated with incumbent FOEs differ from those associated with new FOEs in some cases. Newly acquired FOEs, who have more local inter-industry supply chain connections, appear to have played a positive role as a conduit of sharing enhanced productivity after joining the FOE sector. However, acquisitions of highly productive local firms by non-HMT FOEs (i.e., cream skimming foreign direct investment) appear to have had negative effects on the average productivity of some industries in the short run.

JEL classification: F2, O3, O53, P31
Keywords: total factor productivity, restructuring, foreign direct investment, China, spillover

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I. Introduction

A sustained rapid rise in productivity has accompanied breakneck economic growth in China since the late 1990s. At the same time, foreign direct investment (FDI) inflows have increased sharply, apparently aided by China's joining of the World Trade Organization (WTO) in 2001. China became the recipient of the largest global inward FDI flow since the early 2000s, which in turn led to the establishment of a robust foreign-owned enterprise (FOE) sector. One idiosyncrasy of FOEs in China is the origin of foreign investors. Indeed, there are two primary sources of FDI: FDI from Hong Kong, Macao, and Taiwan (HMT hereafter), where investors are typically overseas Chinese, and FDI from other, mainly OECD countries (termed NHMT hereafter).

These two kinds of FDI differ in several aspects. First, HMT investors originally had a chronological first-mover advantage in that they entered Mainland China well before other investors and this could have allowed them to establish stronger local networks that facilitate transactions with local firms (Kamal, 2015). Second, HMT firms tend to have more cultural proximity to local firms given the common language and customs (Wang et al., 2014). At the same, however, as noted by Du et al. (2012), many so-called foreign investors in China are actually domestic investors who channel investment through Hong Kong to take advantage of special treatment for foreign firms (so-called "round tripping''); this type of investment would be likely to have no special impact on domestic firms. Third, NHMT firms tend to have a technological advantage over HMT firms (Lin et al., 2009). Fourth, HMT firms tend to focus on the processing exports of products that require relatively simple assembly or production processes, whereas NHMT firms have more sophisticated production processes that might involve local sourcing (Abraham et al., 2010; Girma et al., 2009; Jin et al., 2017).

However, these developments involving external investors have not happened in a vacuum of a placid domestic corporate sector environment. Concurrent with the surge in inward FDI has been the accelerated conversion of the state-owned enterprise (SOE) and collective-owned enterprise (COE) sectors to market economies through the privatization of ownership in China's corporate sector. After a series of successful experiments at local levels, the central authority of China formally allowed diversity in corporate ownership: "[I]n 1993, the Third Plenum of the 14th CCP Congress endorsed the creation of a modern enterprise system, which approved the development of diversified forms of ownership including private ownership" (Xu, 2011, p. 1125). Such changes were most drastic in the SOE sector in the late 1990s and early 2000s.[1] According to the NSO survey of firms, the proportion of SOEs and COEs fell from 35.5% and 35.4%, respectively in 1998 to 3.5% and 5.8% in 2007. The corresponding proportion of privately owned enterprises (POEs) rose from 13% in 1998 to 70.7% in 2007).

[1] According to Xu (2011), "[p]ressured by rapidly growing SOE debts and mounting state bank-held NPLs [non-performing loans], bankruptcy reform emerged as a top-priority issue in the 1990s. … As a result, the state sector was significantly transformed, from losing 285 billion RMB in 1998 to profiting 99 billion RMB in 2000 and 627 billion RMB in 2005. … SOE productivity in the corresponding period also improved significantly" (pp. 1123–1124). The privatization of SOEs was thus a major part of the SOE restructuring process. See also Hsieh and Song (2015).

Studies that have examined the evolution of macroeconomic and industrial productivity have noted the potential role played by such a scale of corporate sector restructuring (Brandt et al., 2012). However, only recently have close examinations of the productivity effects of privatization by using firm-level data been carried out (Hsieh and Song, 2015; Chen et al., 2017). This study focuses on the intersection of two major trends of FDI and corporate sector restructuring: the role of FOEs in the restructuring and the spillover effects of new FOEs that changed ownership types as they were acquired by incumbent FOEs. We first examine the productivity, in terms of total factor productivity (TFP), consequences of the restructuring by using detailed firm-level data on manufacturing sectors from 1998 to 2007. The ownership affiliations of a large number of firms changed from the state to the private sector, from domestically owned to foreign owned, and from one type of foreign ownership to another during this period. We examine the key characteristics of firm-level TFP changes and decompose firm-level TFP growth into each ownership category by using the dynamic Olley–Pakes method. Then, we examine the spillover effects of FDI, paying special attention to the fact that FOEs have played an important role in this restructuring process. We follow the empirical methodology first proposed by Javorcik (2004) to examine the productivity spillover effects of FOEs on local firms by paying special attention to the role of newly acquired FOEs.

Distinguishing newly acquired FOEs from incumbent ones by examining the spillover effects is important in several regards. Firstly, it can shed light on the short-term effects of the FOEs created through FDI. This is analogous to Chen et al. (2017), who examine the short-term dynamics of the productivity profiles of privatized SOEs. Secondly, new FOEs might have distinct spillover effects from those of incumbent FOEs because they have close supply chain links with local firms. Finally, examining the horizontal (i.e., within-industry) spillover effects of new FOEs separately could tell us whether foreign direct investors have exhibited a cream skimming modus operandi, as elaborated on by Razin and Sadka (2007), in China. That is, if FOEs were systematically acquiring only highly productive local firms, then the market exit of these productive firms could have a negative impact on the average productivity of the industry to which new FOEs used to belong.

This study contributes to the literature on FDI in China in two ways. Firstly, we examine TFP consequences of the corporate sector restructuring and privatizations to different groups of firms delineated by ownership types. Secondly, we incorporate the corporate sector restructuring into gauging productivity spillover effects of different types of FOEs.

The remainder of this paper is organized as follows. Section II reviews the relevant literature. Sections III examines how privatization and restructuring affect the TFP of firms with different ownership affiliations. Section IV examines the productivity spillover effects of FOEs. Finally, Section V summarizes the findings and concludes.

II. Literature review

International technology spillovers are considered to be a major source of technological progress in developing countries (Grossman and Helpman, 1991). Although there are many ways in which to acquire new technology, FDI may be the cheapest means of technology transfer (Damijan et al., 2013). To realize such benefits, China, among other countries, has

offered incentives to attract FDI inflows.

The positive effects of FDI such as technical spillovers on host countries through the demonstration and movement of workers (Teece, 1977; Aitken and Harrison, 1999; Markusen and Venables, 1999) often have corresponding negative effects. For instance, a negative spillover on domestic firms, especially in developing countries, could arise, such as market-stealing, or competition effects (De Backer and Sleuwaegen, 2003; Zhang, 2001, Lu, Tao, and Zhu, 2017). Furthermore, the lack of absorption capacity in host countries could dilute the positive effects (Kokko, 1994; Borensztein et al., 1998; Kinoshita, 2000). Hence, as Javorcik (2008) points out, the relative magnitudes of these channels depend on host country conditions and types of FDI inflows, which explains the seemingly inconsistent findings in the literature. The focus of the debate should thus shift from attempting to generalize about whether FDI leads to productivity spillovers to determining under what conditions it might do so.

Many studies of China have explained the spillover effects of FDI in different ways. Abraham et al. (2010) analyze the impact of FDI on the performance of more than 15,000 firms in the manufacturing sector during 2002 and 2004. They show that the magnitude of horizontal spillovers depends on the origin and structure of FDI, export status of domestic firms, and characteristics of the special economic zones in which firms operate.

Du et al. (2011) investigate similar issues by using data from 1998–2007. They focus on different sources of FDI, heterogeneous ownership structures, and industrial promotion via tariffs or through tax holidays given to FDI. They find robust positive and significant spillovers to domestic firms via backward linkages (the contacts between foreign buyers and local suppliers) and shows that final goods tariffs as well as input tariffs are negatively associated with firm-level productivity.

By using firm-level production data and product-level trade data on technology-intensive sectors over 2000–2007, Fu (2011) examines the impact of processing trade FDI on the export performance of local firms from two channels, namely technology spillovers and export-related information spillovers, as emphasized by Aitken and Harrison (1999). She finds that processing trade FDI generates a significant positive information spillover effect on the export performance of local firms, but a negative technology spillover effect.

Jeon et al. (2013) expand the scope of technology levels and examine whether FDI spillover effects differ among firms in industries classified by different technological levels, using firm-level data during 1998–2008. They find that foreign investments in the same industry are more likely to generate negative influences on local Chinese firms and that these negative horizontal effects are particularly prominent in low technology sectors. However, the vertical effects of FDI (inter-industry spillovers) appear to be positive and significant relatively evenly across industries with different technological levels.

Anwar and Sun (2014) assess the FDI spillover effects of FDI firms, focusing on the heterogeneity and nonlinearity in the spillovers by using Chinese firm-level panel data over 2000–2007. Buckley et al. (2007) examine a similar set of issues by using data from an earlier period. They find that the productivity spillovers arising from FDI from HMT and NHMT countries exhibit different spillover patterns regarding the magnitudes of investment as well as the levels of technology (or product quality) of local firms.

Recent study by Lu, Tao and Zhu (2017) offers a careful and detailed empirical evaluation

of two opposite spillover effects of inbound FDI into China, namely, the agglomeration effect (positive) and the competition effect (negative). They employ various scenarios in which the two opposing influences could vary to explain a negative and significant horizontal productivity spillover effects of FDI on domestic firms.

Most of these studies have overlooked an important restructuring development in the Chinese corporate sector that occurred in the 1990s and 2000s. According to Brandt et al. (2012), the net entry of firms accounted for about two-thirds of the TFP growth of Chinese industries over 1998–2007. A key aspect of this corporate sector restructuring in China was the privatization of SOEs as well as switches between ownership types. Given that those churnings influenced aggregate TFP, they must have affected the dynamic patterns of the productivity measures of Chinese firms examined by FDI spillover studies. Examinations might obtain an inaccurate picture of the FDI spillover mechanism in China if they do not account for such corporate sector restructuring. The present study addresses this gap by paying special attention to the role of local Chinese firms newly acquired by FDI that switched to FOEs. We specifically focus on any difference in the spillover effects between existing and newly acquired FOEs on domestic firms, using firm-level panel data spanning 1998–2007.

We first examine the key characteristics of firm-level TFP by using a non-parametric multi-factor productivity approach and then decompose TFP growth into ownership categories by using the dynamic Olley–Pakes method. In the data, approximately one-ninth of firms underwent at least one ownership change during the sample period. Thus, we examine the effect of these ownership changes on firm-level TFP. We focus on the large number of domestic firms acquired by HMT and NHMT FOEs. Our empirical model includes both horizontal and vertical spillover effects based on the procedures of Xu and Sheng (2012), which follow the two-stage estimation procedure of Woodridge (2006).

Our focus on differentiating acquired firms from HMT and NHMT countries parallels that of Kamal (2014), who finds that domestic firms acquired by NHMT FOEs outperform HMT acquired firms. However, our focus is placed on the role of those acquired firms in the mechanisms how FOEs affect the productivity of local firms. The acquisition of Chinese firms by an existing FOE implies a flow of workers and information stocks into local supply chains in the reverse direction found in studies of the technology spillover effects of FDI. This in turn could influence and/or alter the findings of earlier empirical studies that examined the technology spillover effects of FDI firms on local Chinese firms.

III. Corporate sector restructuring in China

1. Data

We use firm-level data on manufacturing sectors for 1998–2007 from the *Annual Survey of Industrial Firms*, compiled by the National Bureau of Statistics in China. The census covers the key economic variables of industrial enterprises of a designated size including all SOEs regardless of revenue and non-SOEs whose revenue from their principal business exceeded 5 million RMB from 1998 to 2006 (for 2007, the 5 million RMB threshold was applied to SOEs too). There are 165,118 firms in 1998 and 336,768 firms in 2007. Altogether, there are

approximately 575,000 firms (2,228,727 observations)[2] and manufacturing firms account for about 92% of the dataset.

Several screening procedures are implemented to purge the data of inconsistencies following Du et al. (2012), Brandt et al. (2012, 2014), and Yu (2015) (see the Appendix for an explanation of the data treatment). This dataset has been widely used in previous empirical studies (Cai and Liu, 2009; Hsieh and Klenow, 2009; Fu, 2011; Nie et al., 2012; Brandt et al., 2012; Xu and Sheng, 2012; Yu, 2015) and is considered to be of high quality (Holz, 2005). Finally, the processed sample (see the Data treatment in the Appendix for details) includes 443,369 manufacturing firms (1,504,379 observations).

Based on the type of registration, we separate the sample into five ownership type groups: SOEs, COEs, POEs, HMTs, and NHMTs. <Table 1> shows their proportions of firms in China in 1998–2007. The substantial changes in the proportions of the firms belonging to different ownership groups shown in <Table 1> reveal that a large-scale reform involving the SOE sector occurred in the first half of the sample period. The number of SOEs and COEs fell rapidly, while that of POEs rose sharply. The combined proportion of the number of SOEs and COEs declined from 70.9% (35.5% and 35.4%, respectively) to approximately 9%, while the proportion of POEs increased from 13% to 70.7% from 1998 to 2007. Thus, we focus on the firms belonging to the POE category as representative domestic firms in China.

The distribution of the two types of FOEs also show distinct patterns. The key distinction is that NHMT firms have higher TFP compared with their HMT counterparts, as shown in <Figure 1>. HMT firms maintained an almost constant proportion over time (approximately 10%), while NHMT firms increased their proportion from 6.5% in 1998 to 10.5% in 2007, overtaking that of HMT firms in 2004. This finding suggests a steady and substantial rise in inbound FDI from NHMT countries. The sharp increase in Korea's FDI into China is one such case.

2. Characteristics of the productivity of firms

We next examine the frequencies of ownership type switches, as shown in <Table 2>. Altogether, 392,034 firms belonged to the same ownership type throughout the sample period, 88.4% of all firms. Approximately 11% switched their affiliation at least once. Along with the number of firms, <Table 2> shows the average changes in the number of employees and average changes in TFP for each group.

The distribution of switch frequencies clarifies that the privatization of SOEs and COEs (1→3 and 2→3) was the dominant mode of firm ownership changes in this period. In both cases, the number of switches rose steadily from 1999 before peaking in 2004 and then fell noticeably thereafter. The numbers of SOEs to POEs and COEs to POEs in 1999, 2004, and 2007 were 416 and 1953 (1999), 686 and 4,345 (2004), and 134 and 1,015 (2007). The Chinese government's efforts to restructure loss-making SOEs and the attendant NPL problems of banks

[2] Since firm name or corporate ID may change because of restructuring, acquisition, or merging, the construction of panel data is a challenge. We use the matching algorithm provided in Brandt et al. (2012) to perform the firm matches over time. For more detailed information on the data, see the Appendix.

in the late 1990s explain the chronological profile of those figures (Xu, 2011).

The information on the workforce adjustment in <Table 2> is also informative. First, it shows that the privatization of SOEs involved a higher reduction of employees compared with that of COEs. However, the relatively small averages in the third column are misleading when we compare their standard deviations. For example, more than 30% of all SOE to POE switches increased or reduced workforces by more than 600 employees. That is, the standard deviation of the employee adjustment made by firms in that category was 612. Second, the reverse privatization cases (i.e., 3→1 and 5→1) took place with large-scale workforce adjustments even though they were not as common as ordinary privatization cases. The standard deviations of the first and second cases were 1,501 and 2,427 employees, respectively. This finding implies that as the part of the official privatization policy of "retain the large, release the small,"[3] a sizeable number of non-SOEs in strategically important sectors were brought into the SOE sector for consolidation via reverse privatization.

The fourth column shows the changes in the TFP of firms in each group before and after the switch. We derive the TFP of individual firms by using the multi-factor productivity method of the chained multilateral index number approach, a non-parametric method proposed by Caves et al. (1982) and Good et al. (1997). Labor, capital, and materials (deflated) are the input factors used and the output variable is the nominal values of output deflated by the appropriate industry prices following Brandt et al. (2012):

$$\ln TFP_{it} = (lnY_{it} - \overline{lnY_t}) + \sum_{s=2}^{t}(\overline{lnY_s} - \overline{lnY_{s-1}}) - \sum_{j=1}^{N}(S_{jit} + \overline{S_{jt}})(lnX_{jit} - \overline{lnX_{jt}}) - \sum_{s=2}^{t}\sum_{j=1}^{N}(\overline{S_{js}} + \overline{S_{js-1}})(\overline{lnX_{js}} - \overline{lnX_{js-1}}) \quad (1)$$

where *TFP* denotes the TFP of firm *i* and Y_{it}, S_{jit}, and X_{jit} denote firm *i*'s year *t* output, cost share of input *j*, and amount of input *j*, respectively. The symbols with an upper bar are the corresponding measures for the hypothetical firm. The subscripts are the time and input indices, respectively. The year 1998 is chosen as the base year.

In all cases except one (3→1), the switches were accompanied by gains in TFP. This finding confirms the general economic rationale that the corporate restructuring in China during the sample period enhanced productivity. The single exception also confirms the nature of reverse privatization regarding consolidating key strategic sectors regardless of the short-term economic costs.[4] We next examine whether the gain in TFP sustained.

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[3] See Xu (2011) and Hsieh and Song (2015) for more detailed discussions.

[4] The top five industries (codes shown in parentheses) of the reverse privatization cases for POE→SOE, were Manufacturing of chemical products (26), Manufacturing of non-metallic mineral products (31), Processing of food (13), Manufacturing of general purpose machinery (35), and Manufacturing of automobiles (37). For POE→COE, the only difference is that Manufacturing of textiles (17) replaces Manufacturing of automobiles (37). Firms belonging to these lists made up approximately 45% and 30% of all reverse privatization cases for SOEs and COEs, respectively.

3. Dynamic productivity effects of the corporate sector restructuring

Given the improved TFP observations in <Table 2>, it is interesting to see if they persist. We calculate for year *t*+2 the TFP of the firms whose productivity improvements in period *t* were shown in the earlier table. We construct an unbalanced panel dataset for four consecutive years, namely *t-1*, *t*, *t+1*, and *t+2*. The difference in the TFP levels of a firm between two years is calculated first. Then, for each category of ownership type change (e.g., 3→5), a weighted average is calculated by using the value added of the firm in the post-change year. Average TFP calculated by using output weights showed similar patterns. <Table 3> shows the differences before and after TFP for the cases in which more than 500 firms were involved in that particular type of ownership change.

First, the improvements in productivity appear to persist as the values of period *t*+2 tend to be higher than those of period *t*. With two exceptions, namely (3→1) and (4→3), TFP rose between periods *t* and *t*+2. The firms that used to belong to the NHMT group but became POEs and HMTs, namely (3→5) and (4→5), show the most significant rise in TFP over time. The opposite cases, (5→3) and (5→4), do not show a comparable improvement. As seen in these examples, FOEs played an integral part in the corporate restructuring process. It involved acquiring local Chinese firms not only through FDI, but also through sales of FOEs to the private sector. Hence, there are substantial numbers of 3→4 and 3→5 switches as well as 4→3 and 5→3.

Second, large-scale adjustments continued after the switches. In most cases, the number of employees actually increased after a switch. At the same time, the large standard deviations suggest that the workforce adjustments were substantial. For example, the workforce adjustments of privatized SOEs grew even more in period *t*+2 than in *t*, from 635 (period *t*) to 1,659 (period *t*+2).

Changes in workforce are accompanied by substantial firm consolidations in all categories. In 10 of the 12 cases, the number of firms in period *t+2* was more than half that in period *t*. For example, in the group of COE firms that switched to POEs, consolidation and attrition reduced their number from 19,681 to 9,942 after two years. At the same time, the net increase in the average number of employees of these firms rose from 2.9 to 27, suggesting a growth in the average firm size in this category. However, there is an important technical reason for the reduction in firm numbers in period *t*+2. Owing to the shortness of the sample length, no observations existed for many of the firms switching in this period.

Third, a noticeable increase in employee size as well as a fall in TFP are seen in the POE-to-SOE group, suggesting the effects of reverse privatization, which reflect the government's policy of retaining and growing strategically important sectors. Rising TFP might thus not be a high priority for the managers of the firms in this category.

We look for further evidence to corroborate the consolidations suggested by the reductions in the number of firms between periods *t* and *t*+2. The proportion of firms whose real output more than doubled in the three years following the change was 16.5%. Contemporaneously, the proportions of the number of firms whose employment and real capital stock doubled were 6.8% and 12.9%, respectively. That output increases surpass input increases suggests a significant contribution of efficiency gains from the consolidation of the Chinese corporate sector in the sample period.

Moreover, <Table 2> and <Table 3> show a number of changes in affiliations from local to FOEs and vice versa. Of these, firms that changed ownership from domestic-owned (1, 2, 3) to FOEs (4, 5) could have played important roles as conduits of linking the supply chains of local and FOEs, which might have affected the vertical spillover effects of FOEs to domestic industries. We turn to this in the following subsection.

4. Restructuring among FOEs

The restructuring among FOEs in the corporate sector privatization and restructuring processes in China is underexamined in the literature. The firm-level data in <Table 4> indicate substantial bidirectional flows of firms between the HMT and NHMT groups from the late 1990s. The temporal profiles of intra-FOE flows appear to be more evenly spread throughout the sample period unlike those of Chinese firms, which exhibit a uniform increase in the number of switching firms until 2004 followed by a rapid fall. There were 4,227 and 4,314 observations for changes in ownership type from POE to HMT (3→4) and POE to NHMT (3→5) in the sample period, respectively. By comparison, there were 11,963 and 9,998 observations for intra-FOE switches, namely HMT to NHMT (4→5) and NHMT to HMT (5→4), respectively.

The survey data show additional geographical and industrial differences between the HMT and NHMT groups beyond owners' regional origins. Within China, the geographical distribution of HMT firms is more concentrated in coastal regions (90%), whereas NHMT firms are slightly more dispersed: coastal 84%, northeast 7.8%, and inland 4.7%.

By industry, the top five firm/industry observations for HMT are 17 (Textiles, 10.22%; see the Appendix for more details on the two-digit China Industry Classification codes), 30 (Plastic, 7.74%), 40 (Computers, communication/electronic equipment, 7.55%), 34 (Metal products, 5.46%), and 26 (Chemical, 5.01%). The same for NHMT are 18 (Textiles/clothing/apparel, 8.73%), 40 (8.39%), 17 (7.06%), 35 (General purpose machinery, 6.82%), and 39 (Transportation equipment, 6.65%). The regional and industrial consolidations due to these differences could explain why we see so many bidirectional flows between the HMT and NHMT sectors.

<Table 4> compares the key characteristics of the average firms of the four groups of FOEs. Here, 44-type and 55-type firms are whose ownership type remains HMT and NHMT throughout the sample period, respectively, whereas 45-type and 54-type are switchers from HMT to NHMT and from NHMT to HMT, respectively. First, there are more large firms in the 55 NHMT group than in the 44 HMT group. In terms of output, the average, standard deviation, and maximum output of 55-type firms are larger than those of 44. In terms of workforce size, the averages are similar but the standard deviation and maximum of 55-type firms are much larger than those of 44-type firms. Second, 55-type NHMT firms tend to be more capital-intensive (i.e., high capital/labor ratios), and more productive (in terms of TFP) than 44-type HMT firms. Third, the HMT sector tends to acquire larger firms, compared with their average size, from the NHMT sector in terms of output. On the contrary, the NHMT sector tends to acquire HMT firms with a larger workforce than incumbent NHMT firms. Both groups of acquired firms appear to be equally productive in terms of the average of log (TFP), although the maximum TFP of type-45 firms is larger than that type-54 firms.

5. TFP growth decompositions

Next, we examine the sources of the TFP changes of firms in different ownership groups. TFP growth can be decomposed into three sources (survivors, entrants, and exiters) according to the dynamic Olley–Pakes decomposition method proposed by Melitz and Polanec (2015). The left-hand side of equation (2) represents the growth in TFP of group *j* between periods *t-1* and *t* that can be attributed to the different components on the right-hand side:

$$\Delta P_{jt} = \left(\overline{P_{jt}^{C}} - \overline{P_{jt-1}^{C}}\right) + \sum_{i \in C}\left[\left(S_{it-1}^{C} - \overline{S_{it-1}^{C}}\right)\left(p_{i,t-1} - \overline{P_{j,t-1}^{C}}\right)\right] + S_{jt}^{N}\left(P_{jt}^{N} - P_{jt}^{C}\right) + S_{jt-1}^{X}\left(P_{jt-1}^{C} - P_{jt-1}^{X}\right)$$

$$= \Delta\overline{P_{jt}^{C}} + \Delta cov_{jt}^{C} + S_{jt}^{N}\left(P_{jt}^{N} - P_{jt}^{C}\right) + S_{jt-1}^{X}\left(P_{jt-1}^{C} - P_{jt-1}^{X}\right) \quad (2)$$

First, the contribution of surviving firms can be separated into two parts: one induced by a shift in the distribution of firm productivity (the unweighted mean change in the productivity of surviving firms, $\Delta\overline{P_{jt}^{C}}$) and another induced by market share reallocations (the covariance change between market share and productivity for surviving firms, Δcov_{jt}^{C}). The covariance term would add positively if a more productive firm's market share increases or a less productive firm's market share decreases. Second, newly entering firms would add positively (negatively) if their productivity is higher (lower) than the group of incumbent firms. The third term of equation (2), $\left(P_{jt}^{N} - P_{jt}^{C}\right)$, captures this, where S_{jt}^{N} represents the output share of newly entering firms in group *j*. Third, exiting firms would add positively (negatively) if their productivity is lower (higher) than surviving firms. The last term, $\left(P_{jt-1}^{C} - P_{jt-1}^{X}\right)$, captures this, where S_{jt-1}^{X} represents the period *t*–1 output share of exiting firms in group *j*.

To focus on the effect of entry and exit, we use the three-year rule suggested by Ciobanu and Wang (2012) to exclude short-lived surviving firms (that survived only one year from the analysis). Consequently, decompositions are possible only from 1999 to 2006. The results in <Table 5> show that the average contribution shares of each column over the sample period in the bottom row are useful to summarize an overall role of each source.

The top block of <Table 5> shows the figures for all firms in the sample. This is the decomposition of the changes in TFP shown in the last column of "Total" of <Table 5>. The last row of the first block ("contribution") shows that the largest contribution to overall TFP growth comes from the productivity improvements of surviving firms followed by the relocation effect measured by the covariance term. Entry and exit added to the TFP growth of manufacturing firms in this period equally.

The key patterns seen in the five ownership groups differ from those of the overall sample. For the two FOE groups (HMT, NHMT), internal improvements by continuing firms (i.e., $\Delta\overline{P_{jt}^{C}}$ of equation (2)) are a much more important source of TFP increases, as they account for 73% (HMT) and 92% (NHMT) of all increases in TFP. By comparison, internal and external changes [i.e., the three terms of Δcov_{jt}^{C}, $S_{jt}^{N}\left(P_{jt}^{N} - P_{jt}^{C}\right)$, and $S_{jt-1}^{X}\left(P_{jt-1}^{C} - P_{jt-1}^{X}\right)$ of equation (2)] are equally important sources of the productivity improvements of SOEs, COEs, and POEs. The within-factors account for about 50% of TFP changes. This finding suggests that FOEs, which tend to be more concentrated in a smaller number of industries, have more stable market shares in their respective areas and are not as affected by entering and exiting firms compared with local firms.

Newly entering firms add to TFP growth only in the COE and POE groups. This observation

about the POE group is remarkable given that so many firms switched into this group (25,757 of the total of 41,770). The fact that more than half of privatized enterprises were sold to firm managers (i.e., management buyout) might have contributed to the POE sector obtaining a positive productivity growth contribution from newly entering firms.[5]

At the same time, the POE group is the only case when exiting (switching as well as going bankrupt) firms made a negative contribution to the group's productivity growth. This finding implies that exiting firms had close to or above average levels of TFP because their market exit lowered the group's TFP. According to <Table 2>, approximately 3,410, 1,260, and 1,320 firms left the POE group and switched to the COE, HMT, and NHMT groups, respectively. In the year immediately following switches, their TFP rose by 0.077, 0.136, and 0.097, respectively. These figures suggest that the POEs acquired by the other groups were potentially high performing firms.

The fact that no other ownership types experienced negative TFP consequences from exiting firms including HMT has an implication for the cream skimming mode of acquisitions by NHMT and HMT firms. However, this modus operandi might apply to the acquisitions of POE firms by HMT and NHMT ones. As discussed above, POE firms that switched to the FOE sector were likely to have been those with above-average TFP performance.

Taken together, the corporate sector restructuring contributed positively to productivity growth in China's manufacturing sectors. The top section of <Table 5> shows that entry, exit, and other internal and external changes added to TFP growth. Hence, the breadth of corporate sector changes in China appears wider than that found by earlier studies. In the remainder of the paper, we examine the spillover effects of FOEs by paying close attention to the roles played by newly acquired domestic firms.

IV. Spillover effects of the FOEs of HMT and NHMT

1. Estimation model

To examine and compare the correlation between a firm's productivity and the different origins of the intra- and inter-industry FDI spillover effects, we start with a specification following Xu and Sheng (2012):

$$\ln Y_{ijrt} = \alpha_0 + \alpha_1 Horizontal_{jt} + \alpha_2 Fward_{jt} + \alpha_3 Bward_{jt} + \alpha X + \alpha_j + \alpha_r + \alpha_t + \varepsilon_{ijrt} \qquad (3)$$

where Y_{ijrt} is domestic firm i's TFP in industry region r at time t. Following Javorcik (2004), we define three-sector level variables to measure the spillover effect. First, $Horizontal_{jt}$ captures the extent of foreign presence in sector j at time t and is defined as foreign equity participation averaged over all firms in the sector, weighted by each firm's share of sectoral output. Its formal definition is as follows:

[5] According to Xu (2011), "[p]rivatization in China has created concentrated private ownership and about half of privatized firms in China were sold to managers i.e. through [management buyout], which has greatly changed corporate governance and corporate performance… [Guo, Gan, and Xu, 2008] found that among all privatization methods, only [management buyout] had statistically significant positive impacts to the restructuring, corporate governance and performance" (p. 1126).

$$Horizontal_{jt} = \left[\sum_{i \text{ for all } i \in j} FShare_{it} * Y_{it} \right] \Big/ \sum_{i \text{ for all } i \in j} Y_{it},$$

where $FShare_{it}$ is defined as the proportion of firm i's total equity owned by HMT and NHMT investors. We use two kinds of $FShare$ variables to distinguish the sources of FDI: $FShare_{HMT}$ for the proportion of the firm's total equity owned by HMT investors and $FShare_{NHMT}$ for the proportion of the firm's total equity owned by NHMT investors. To compare the spillover effects of the existing and newly acquired groups, we separate $FShare_{HMT}$ and $FShare_{NHMT}$ into two subgroups: $FShare_{HMT\_old}$ and $FShare_{HMT\_new}$ as well as $FShare_{NHMT\_old}$ and $FShare_{NHMT\_new}$, respectively. This convention applies to the remaining variables defined below.

Second, $Fward_{jt}$ is defined as the weighted share of output in upstream (or supplying) sectors produced by firms with foreign capital participation. As Javorcik (2004) points out, since only intermediates sold in the domestic market are relevant to the study, goods produced by foreign affiliates for exports (X_{it}) should be excluded, especially for China in which export platform-type FDI is a common phenomenon:

$$Fward_{jt} = \sum_{m \text{ if } m \neq j} \delta_{jm} \left[\left[\sum_{i \text{ for all } i \in m} FShare_{it} * (Y_{it} - X_{it}) \right] \Big/ \left[\sum_{i \text{ for all } i \in m} (Y_{it} - X_{it}) \right] \right]$$

where δ_{jm} is taken from the 2002 input/output table representing the share of inputs purchased by industry j from industry m in the total inputs sourced by industry j. Y_{it} is the total output and X_{it} is the exports of firm i at time t. Since $Horizontal_{jt}$ already captures the linkages between firms within an industry, the inputs purchased within the industry are not included.

Finally, $Bward_{jt}$ captures the foreign presence in industries being supplied by industry j. Therefore, $Bward_{jt}$ aims to capture the extent of potential contacts between domestic suppliers in the upstream sectors and foreign customers in the downstream sectors:

$$Bward_{jt} = \sum_{k \text{ if } k \neq j} a_{jk}\ Horizontal_{kt}$$

a_{jk} is also taken from the 2002 input/output table representing the proportion of industry j's production supplied to industry k. For the same reason as before, inputs supplied within the industry are not included.

X is a vector of five control variables. The first two control variables, FDI_{HMT} and FDI_{FOE}, defined as the capital share of HMT and FOE investors in domestic firms, respectively, are included to isolate the impact of foreign capital's participation in a firm on its own productivity from spillovers from the FDI presence in the industry. The third variable is the Herfindahl index (*HHI*), which is included as a proxy for the level of industry concentration (the sum of the squared market shares of the top eight firms in a given industry). The fourth variable is the market share of a firm in a given industry, *MS*. This is included to further isolate the spillover

effects from those due to the market power of the firm. The last control variable is a dummy variable $SWITCH_{it}$, which takes 1 if the firm switched ownership group before period t and 0 otherwise. This is used to control for the productivity effects of ownership changes on local Chinese firms, as discussed in the previous section. All the control variables except *HHI* are included to control for firm-specific characteristics. α_j, α_r, and α_t are the two-digit industry dummies, regional dummies (see <Table B> of the Appendix for details), and year dummies, respectively.

Following Xu and Sheng (2012), we use Woodridge's (2006) two-stage method to correct the cluster effect. In the first stage, we treat each industry year as a group and regress firm productivity on the firm-level variables within each group, separately controlling for the regional effect. The equation used for each group in the first-stage estimation can be written as

$$lnY_{ir} = \overline{\delta_{jt}} + r_1 fdi_{ir} + r_2 MS_{ir} + r_3 SWITCH_t + \alpha_r + \omega_{jt} \quad (4)$$

We obtain each group's constant term $\overline{\delta_{jt}}$ and standard error $se(\overline{\delta_{jt}})$ from equation (4), and use them in the second-stage equation:

$$\overline{\delta_{jt}} = \beta_0 + \beta_1 Horizontal_{jt} + \beta_2 Fward_{jt} + \beta_3 Bward_{jt} + HHI_{jt} + \alpha_t + v_{jt} \quad (5)$$

We use weighted least squares to estimate equation (4), where each group is weighted by $M_g/[se(\overline{\delta_{jt}})]^2$, where M_g is the number of firms in each group. Hence, the groups for which there are more data and a smaller variance receive greater weights.

Finally, the first difference of equation (4) is taken to remove the simultaneity bias problem arising from important unobservables that vary both across industries/regions and over time:

$$\overline{\Delta\delta_{jt}} = \beta_0 + \beta_1 \Delta Horizontal_{jt} + \beta_2 \Delta Fward_{jt} + \beta_3 \Delta Bward_{jt} + \beta_4 \Delta HHI_{jt} + \alpha_t + v_{jt} \quad (6)$$

To compare the spillover effects of the existing and newly acquired groups on the TFP of Chinese domestic firms, we are interested in how the parameters β_1, β_2, β_3 differ in equations (5) and (6). <Table 6> describes the summary statistics for the three variables in four forms.

2. Estimation Results

The focus of our analysis is on the heterogeneous dynamics across new and old FOEs in the HMT and NHMT groups. FDI inflow into China picked up around the mid-1990s and then grew rapidly again after 2001–2002 following China's entry in the WTO. At the same time, HMT FOEs established a foothold earlier than their NHMT counterparts, who became more numerous in the post-WTO entry period. This relative pattern can be seen in <Table 1>. Thus, one could expect a bimodal distribution of the tenures of FOEs in China, with the first and second peaks coinciding with the timing of the first and second surges of FDI inflows. In addition, new FOEs came into being around the second FDI inflow surge, reflecting the effects

of the active privatization and corporate sector restructuring overviewed earlier.[6]

<Table 6> shows the summary statistics for the explanatory variables used to estimate the equations explained in the previous section. Three elements describe each variable name. The first prefix (*Old*, *New*) denotes the two types of FOEs (depending on whether a firm was an original member of the HMT or NHMT groups in 1998 or a newly acquired member since 1998). The second denotes the type of spillover effect: horizontal (i.e., intra-industry) or forward/backward vertical (i.e., inter-industry). For example, *Old_hori_HMT* is the name of an explanatory variable that measures the horizontal spillover effects of incumbent HMT firms on domestic firms.

The size of variables measuring the extent of foreign capital shares, *_hori_HMT* and *_hori_NHMT*, is related to FDI by the HMT and NHMT groups. The magnitude of NHMT shares (incumbent plus new) is larger than that of HMT. This finding reflects the fact that the sums of paid-in capital by HMT and NHMT types calculated from the census data were 0.8 and 1.45 trillion RMB in 2007.

Next, we show the estimation results of equations (5) and (6). First, we analyze HMT FDI and NHMT FDI separately to identify their individual effects. This ensures that these effects are unaffected by the possible correlation between the two types of FDI spillover variables (<Table 7> and <Table 8>) and then we analyze them together (<Table 9>). As mentioned earlier, we include regional and industry dummy variables in all specifications to address the potential endogeneity problems of more productive regions and industries receiving more FDI (e.g., Abraham et al., 2010). The year dummy is used to control for common macroeconomic shocks.

The first two tables show the results of identical models estimated by using levels as well as first differences. When the results from the two models are different, we place more weight on the results from the latter for two reasons. First, the contemporaneous cross correlations between some of the explanatory variables in levels are high (larger than 0.6), while we do not observe such a pattern in those between the explanatory variables in first differenced forms. Second, the use of first differenced variables helps mitigate potential simultaneity problems in the dependent and explanatory variables used in the estimation equations, as explained in Xu and Sheng (2012).

3. Inter-industry spillover effects

<Table 7> shows the estimates of the horizontal and vertical spillover effects of HMT and NHMT, with incumbent and new firms combined. The coefficients of the horizontal spillover effects are consistently positive, while those for the vertical effects are mixed, or negative in the case of the vertical spillover effects of HMT. This finding implies that the productivity of local firms that supply intermediate goods to HMT FOEs, or that obtain intermediate goods

[6] The number of firms that switched from POEs (type 3) to either of the HMT or NHMT categories rose sharply in 2003 and remained relatively flat thereafter. The number of switchers from POE to HMT (3→4) were 77 (2003), 376 (2004), 116 (2005), 262 (2006), and 212 (2007). For POE to NHMT (3→5), they were 78 (2003), 379 (2004), 160 (2005), 268 (2006), and 253 (2007).

from them, does not benefit from the linkage (negative effects). That is, the vertical spillover effects of HMT are negative, while those of NHMT are positive. This finding is in line with earlier studies that examined similar spillover effects (e.g., Lin et al., 2009; Du et al., 2011; Jeon et al., 2013; Anwar and Sun, 2014). They generally attribute this divergence to more advanced technology associated with NHMT FOEs. Local Chinese firms have more to learn from establishing inter-industry supply and demand linkages with NHMT firms; indeed, they have benefited from them, but not from HMT FOEs, according to the estimates in <Table 7>.

Next, we turn to <Table 8> to see whether the results in <Table 7> for the HMT and NHMT groups hold when we divide each sample into incumbent (*Old*) and newly acquired (*New*). For HMT, the estimation results of the two specifications show that incumbent FOEs (*Old*) are associated with negative vertical spillover effects (mixed for *forward* but consistent for *backward*) as was the case in <Table 7>. However, newly acquired HMT FOEs (*New*) are associated with positive vertical spillover effects. This finding implies that among local firms with inter-industry supply and demand linkages to FOEs, only those that have a relationship with newly acquired HMT firms enjoy positive productivity spillover benefits from the linkage. This pattern is also present in <Table 9>.

A likely explanation is as follows. Many incumbent (*Old*) HMT firms are processing trade exporters who tend to source from abroad and ship their semi-final good outputs to their associates in home bases. By contrast, the local firms included in the *New_forward* and *New_backward* groups are those that had supply and demand linkages to the previously local firms that became FOEs. Once these firms became a part of the HMT group, their local linkage become the conduit to the consequent productivity spillover benefits to those local firms in different industries that already had supply and demand links.

The same kind of divergence across incumbent and new firms can also be seen for the backward spillover effects in the estimation results for NHMT. The explanation for the HMT observations must be applicable in this case, too. However, we do not observe a similar shift in the forward spillover cases. The *Old-forward* coefficients remain positive consistently across the level and the first differenced specifications. This difference in the sign patterns of incumbent HMT and NHMT firms must reflect their different outputs to local firms. If indeed NHMT firms are making products with a higher technological content not available in local markets, then their sales to local manufacturing firms should help boost the TFP of those buyers. This assertion is partly supported by the observation of Kamal (2015) that new NHMT firms tend to have higher TFP growth compared with their HMT counterparts.

4. Intra-industry spillover effects

The coefficient estimates for the horizontal effects are significantly positive in all cases, except in the new NHMT group (<Table 8> and <Table 9>). The presence of HMT firms (both *Old* and *New*) as well as incumbent NHMT firms in a given industry is shown to have significant positive effects. However, new NHMT firms are associated with significant negative effects. This divergence is unusual given that both old and new NHMT firms tend to have higher TFP than their HMT counterparts. NHMT firms tend to be more concentrated in high technology industries than HMT firms, thus offering a more advanced template for the typical

spillover channels of demonstration and imitation to operate in the same industry.[7] With regard to the human capital/labor mobility channel of the spillover, during the sample period, the number of firms switching from HMT and NHMT FOE status to POE, which must have entailed the transfer of managerial and other skills, are 1,172 and 970, respectively (see <Table 2>). Hence, some factors associated with new NHMT firms must have negated the positive intra-industry spillover effects.

One channel is the negative competition effects of FOEs on the domestic market, as suggested by Aitkin and Harrison (1999). However, this explanation does not seem applicable in the case of new NHMT firms because these are pre-existing local firms switching ownership to FOEs as opposed to new FOEs entering industries and thus crowding out existing firms. Cream skimming acquisitions by NHMT might be one explanation. NHMT FDI targeted local Chinese firms with high productivity and acquired them when opportunities arose. The average productivity of the remaining local firms would thus lower if a sufficient number of these high-performing firms, given the industry size, were acquired by NHMT firms. This case shows the negative short-run effect of cream skimming by FDI on the local industry.

To understand the nature of the differences in domestic firms by HMT and NHMT, <Table 10> presents the relevant statistics and characteristics. For both the HMT and the NHMT sectors, this table shows the top 10 industries with newly acquired firms using accumulated horizontal shares. The value represents the relative share of foreign affiliates' output to total industry output. First, there are large differences between the groups of local firms acquired by HMT and NHMT firms. Relatively speaking, the impacts of NHMT acquisitions are more visible in the affected industries in terms of output share.

Second, the NHMT sector tends to acquire local firms with a greater domestic market orientation in terms of the exports/domestic sales ratio. For example, three of the top five NHMT industries have exports/domestic sales ratios of less than 10%, whereas the minimum of the top five industries of HMT is 175%. This presumably suggests that NHMT FOEs are more formidable competitors to domestic firms in the same industry, thus giving a rise to negative competition effects as seen in Lu, Tao and Zhu (2017). It turns out that the food processing industry is the most prominent in acquisitions by the NHMT sector. Indeed, Jin et al. (2017), which focuses specifically on the food processing industry in China following the same Javorcik methodology, provide an identical result.[8]

Third, the HMT sector appears to focus on acquiring firms in industries characterized by low technology according the OECD (2005) classification. Abraham et al. (2010) cite similar factors such as export orientation and industry technology level to explain their finding of negative intra-industry spillover effects on exporting firms for the HMT sector. That is because HMT firms tend to be more concentrated in low technology processing trade, thus putting competitive pressure on Chinese firms in the same industries.

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[7] For discussions of the divergent technology characteristics of HMT and NHMT, see Abraham et al. (2010), Lin et al. (2009), Jeon et al. (2013), Kamal (2015).

[8] According to Jin et al. (2017) "t]he coefficient of … turns out to be significantly negative in column (3), which means that in the food manufacturing industry, non-HMT invested firms harm domestic firms' productivity by crowding out their market share and thus reducing profit margins" (p. 5).

V. Summary and conclusion

This study examined the two related issues of the productivity consequences of the large-scale corporate sector privatization and restructuring in China since the late 1990s and productivity spillover effects of FOEs, which played an important role in the restructuring process, using firm-level data from 1998 to 2007.

In the first part, our analysis compared the characteristics of three domestic firm types (SOEs, COEs, POEs) and two FOE types (HMTs, NHMTs). We found that the restructuring and privatization processes were multifaceted and involved bidirectional switches of firm ownership types. In general, the restructuring appears to have had TFP-boosting effects across the board. However, this was not the only motivation for restructuring. For POEs converted into SOEs, namely reverse privatization cases, the switch had a negative TFP consequence. This finding illuminates the importance placed on retaining large capacity in selected industries deemed strategically important by the Chinese government during privatization. This priority apparently motivated the SOE and COE sectors to absorb some firms regardless of the productivity consequences.

The results of the decomposition of the TFP growth of firms into ownership categories using the dynamic Olley–Pakes method revealed a divergence in the sources of TFP growth of domestic firms (SOEs, COEs, POEs) and FOEs (HMTs, NHMTs). Restructuring-related changes such as entry, exit, and market share changes commensurate with firm productivity levels were more important sources of TFP growth for domestic firms. On the contrary, internal to firm- and/or industry-level improvements in TFP were the main source of the productivity growth of FOEs.

The second issue examined was whether the spillover effects of newly acquired FOEs were distinct from those of incumbent FOEs. The results from the model estimations showed that different types of FOEs were associated with different productivity spillover effects. For incumbent firms, HMT and NHMT had positive horizontal spillover effects; however, their vertical (forward) spillover effects diverged: HMT (negative) vs. NHMT (positive). For newly acquired firms, HMT (NHMT) had positive (negative) horizontal effects. This finding suggests that, in some industries, local firms might have experienced a lowering of average productivity due to the cream skimming acquisitions of highly productive local firms by NHMT FDI in the short run.

FOEs played an enabler role in China's privatization and corporate sector restructuring in the early 2000s, which enhanced the productivity of manufacturing firms overall in the sample period. Despite the indications that FOEs exhibited strategically opportunistic acquisition behavior in some cases, they helped facilitate the necessary restructuring of the corporate sector that could have faced forced reorganization because of its mounting NPL problems. The data show that intra-FOE sector restructuring between HMT and NHMT firms continued steadily during the sample period. Hence, it might not be too unreasonable a speculation to think that such a dynamic churning of the corporate sector must have afforded competitive domestic enterprises as well as FOEs opportunities to realize their potential. However, whether such an assessment might apply to China's corporate sector and economy in general since the late 2000s is an open question and an important area of future research.

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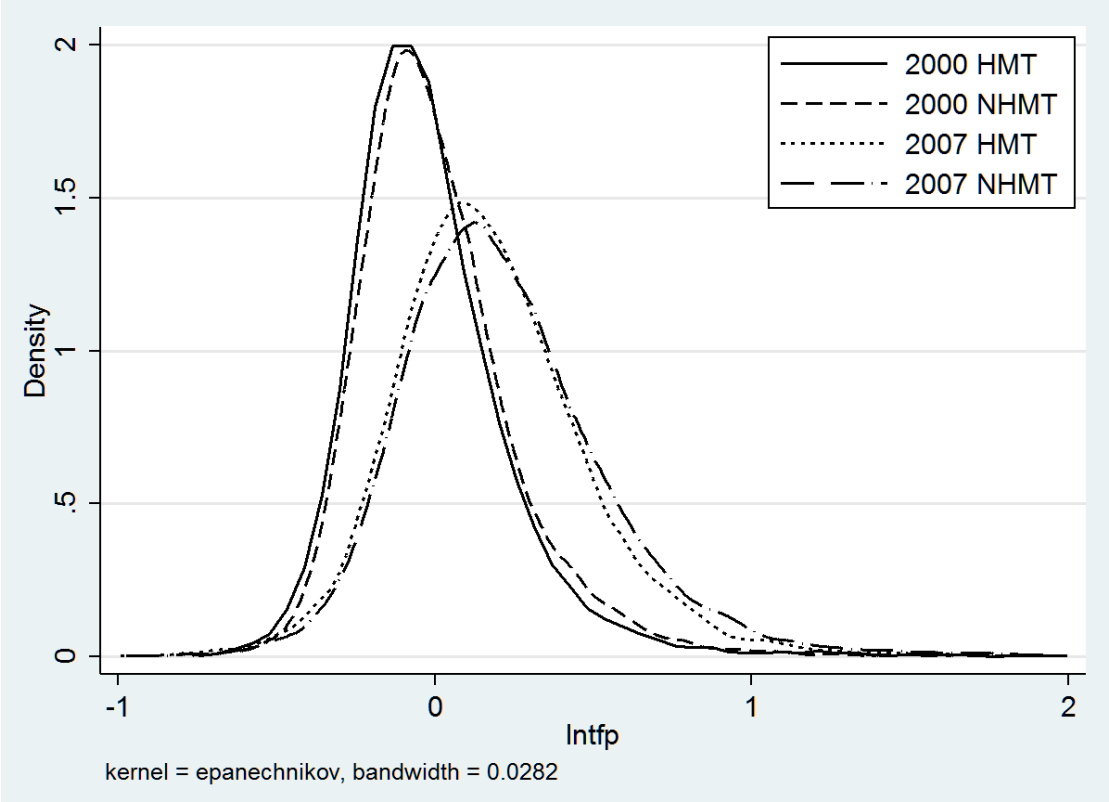
<Figure 1> Distributions of ln(TFP)s of HMT and NHMT firms in 2000 and 2007



<Table 1> Changes in distribution of firms with different ownership types (1998-2007) [1]

Year	SOE (%)	COE (%)	POE (%)	HMT (%)	NHMT (%)	Total
1998	58,666(35.5)	58,493(35.4)	21,510(13.0)	15,727(9.5)	10,722(6.5)	165,118
1999	53,230(32.9)	53,952(33.3)	28,014(17.3)	15,783(9.7)	11054(6.8)	162,033
2000	45,025(27.6)	49,830(30.6)	39,585(24.3)	16,490(10.1)	11,955(7.3)	162,885
2001	37,115(21.7)	42,903(25.1)	59,815(34.9)	18,257(10.7)	13,166(7.7)	171,256
2002	31,861(17.6)	38,571(21.2)	76,659(42.2)	19,546(10.8)	14,920(8.2)	181,557
2003	25,403(13.0)	32,605(16.6)	99,633(50.8)	21,152(10.8)	17,429(8.9)	196,222
2004	27,685(9.9)	27,104(9.7)	167,019(59.8)	28,440(10.2)	28,844(10.3)	279,092
2005	18,690(6.9)	24,040(8.8)	172,718(63.5)	27,559(10.1)	28,828(10.6)	271,835
2006	16,368(5.4)	21,122(7.0)	203,600(67.4)	29,180(9.7)	31,691(10.5)	301,961
2007	11,834(3.5)	19,480(5.8)	237,998(70.7)	31,949(9.5)	35,507(10.5)	336,768

1. SOE; State owned enterprise, COE; collectively owned enterprises, POE; privately owned enterprises, HMT; FDI firms owned by Hong Kong-Macao-Taiwan investors, NHMT; FDI firms owned by non-HMT investors.

<Table 2> type of ownership changes and their frequencies during 1999-2007

Ownership types of firms 1 SOE; 2 COE; 3 POE; 4 HMT; 5 NHMT			
Ownership Switch types	Frequencies	Average changes in the number of employees (standard deviation)	Average changes in the TFPs
1→2	606	-15.1 (142.5)	0.099
1→3	3,934	-38.1 (611.9)	0.112
1→4	72	-44.5 (211.4)	0.090
1→5	73	-121.1 (411.8)	0.026
2→1	393	-0.9 (255.8)	0.107
2→3	19,681	2.9 (157.5)	0.066
2→4	509	-1.7 (230.9)	0.089
2→5	299	9.5(141.5)	0.153
3→1	833	65.2 (1,501.3)	-0.065
3→2	3,409	5.2 (147.7)	0.077
3→4	1,259	49.8 (333.8)	0.136
3→5	1,319	30.7 (359.2)	0.097
4→1	67	10.6 (157.7)	0.029
4→2	264	-12.3 (233.4)	0.014
4→3	1,172	14.8 (180.3)	0.079
4→5	3,877	10.9 (344.6)	0.205
5→1	46	-58.1 (2,426.8)	0.071
5→2	121	26.2 (328.1)	0.016
5→3	970	29.4 (257.5)	0.126
5→4	2,866	39.4 (598.3)	0.094
Total	41,770		

<Table 3> Changes in TFPs of firms that switched ownership type affiliations[1]

Type of ownership changes		Changes in TFP [a]	Changes in the number of employees	Number of firms
		Value added weight	Mean (s. d.)	
1→2	*t*	0.099	-15.1 (145.2)	606 [b]
	t+2	0.122	-12.9 (170.2)	204
1→3	*t*	0.112	-38.1 (635.0)	3,934
	t+2	0.122	-38.9 (1,658.5)	2,015
2→3	*t*	0.066	2.9 (159.7)	19,681
	t+2	0.106	27 (259.0)	9,942
2→4	*t*	0.089	-1.7 (234.7)	509
	t+2	0.118	16.1 (171.4)	261
3→1	*t*	-0.065	65.2 (1,562.9)	833
	t+2	-0.151	336.4 (3,008.0)	173
3→2	*t*	0.077	5.2 (149.1)	3,409
	t+2	0.279	15.4 (159.2)	841
3→4	*t*	0.136	49.8 (334.2)	1,259
	t+2	0.177	99.9 (480.7)	483
3→5	*t*	0.097	30.7 (390.9)	1,319
	t+2	0.128	111.0 (644.6)	507
4→3	*t*	0.079	14.8 (187.1)	1,172
	t+2	0.074	46.1 (328.8)	368
4→5	*t*	0.205	10.9 (341.3)	3,877
	t+2	0.212	94.7 (523.3)	1,328
5→3	*t*	0.126	29.4 (261.5)	970
	t+2	0.238	97.4 (453.9)	274
5→4	*t*	0.094	39.4 (609.6)	2,866
	t+2	0.213	73.6 (389.3)	1,101

1. Only the cases in which the number of firms that switched exceeds 500 at time *t* are shown. The number of firms that changed ownership types are as follows: all→SOE (1,339); all→COE (4,400); all→POE (25,757); all→HMT (4,706); and all→NHMT (5,568). The total is 41,770.

a. Difference between TFP levels of firms after switching (both period *t* and *t*+2) minus TFP of the same firms before the switches (i.e., *t*-1). Weighted averages of the numbers of firms shown in the last column.

b. The difference in the number of firms represents cases in which some firms had exited since switching its ownership affiliation. More important reason for the reduction in the *t*+2 observation has to do with the shortness of the sample period. Privatizations and corporate restructuring started in earnest in 2002. Thus, many firms that changed ownership types thereafter would not have been old enough to have *t*+2 observations.

<Table 4> Key descriptive statistics of HMT and NHMT (44 and 55)[1] firm observations

HMT '44' type firms (Number of observations=157,407)				
variable	Mean [a]	standard dev.	Min.	Max.
Output [b]	88,247	462,186	898	39,237,156
L [c]	317	664	8	52,100
K/L [d]	106	224	0.0	16,860
Ln(TFP)	0.08	0.30	-1.08	4.48
NHMT '55' type firms (Number of observations=142,533)				
Output	188,001	1,570,859	1,340	203,096,656
L	312	1,040	8	188,151
K/L	172	434	0.0	33,348
Ln(TFP)	0.13	0.33	-1.04	5.20
'45' (HMT→NHMT) type firms (Number of observations=11,936)				
variable	Mean	standard dev.	Min.	Max.
Output	193,619	1,036,534	2,577	48,790,268
L	486	1,007	8	23,920
K/L	136	235	0.04	6,612
Ln(TFP)	0.12	0.31	-0.86	4.45
'54' (NHMT→HMT) type firms (Number of observations=9,998)				
Output	163,176	712,771	3,728	24,257,258
L	400	867	8	29,976
K/L	133	283	0.01	15,132
Ln(TFP)	0.11	0.30	-0.89	3.47

1. 44 and 55 designate firms that had maintained the same ownership types of HMT and NHMT throughout their existence in the data set. 45 and 54 are the firms that switched the ownership types during the sample period. Statistics are based on the post-switch observations.

a. Unweighted average over the number of observations;
b. Real output (measured in 1,000 RMB).
c. Number of employees.
d. Real capital (measured in 1,000 RMB) divided by the number of employees.

<Table 5> Decomposition of changes in TFPs of firms under different ownership types time

Year	Changes to due				
	Entering	Exiting	Covariance	Within	Total
All					
2000	-0.0029	0.0026	0.0126	0.0142	0.0265
2001	0.0068	-0.0021	0.0123	-0.0022	0.0148
2002	0.0019	0.0024	0.0155	0.0140	0.0339
2003	0.0011	0.0021	0.0133	0.0192	0.0357
2004	0.0072	0.0011	0.0377	0.0421	0.0881
2005	-0.0010	0.0026	-0.0113	0.0016	-0.0081
2006	-0.0009	0.0018	0.0006	0.0326	0.0341
Contribution	0.0543	0.0464	0.3591	0.5402	1.0000
1.SOE					
2000	-0.0014	0.0006	0.0166	0.0115	0.0274
2001	0.0047	-0.0089	0.0071	0.0052	0.0081
2002	-0.0032	0.0076	0.0228	0.0072	0.0344
2003	-0.0001	-0.0017	0.0132	0.0041	0.0155
2004	0.0013	0.0062	0.0464	0.0489	0.1028
2005	-0.0116	0.0115	-0.0395	-0.0247	-0.0644
2006	-0.0071	0.0057	0.0160	0.0153	0.0299
Contribution	-0.1130	0.1364	0.5380	0.4385	1.0000
2. COE					
2000	-0.0012	0.0060	0.0074	0.0135	0.0257
2001	0.0046	0.0000	0.0118	0.0006	0.0170
2002	0.0004	0.0022	0.0112	0.0157	0.0296
2003	0.0045	-0.0001	0.0089	0.0314	0.0447
2004	0.0061	-0.0017	0.0333	0.0167	0.0544
2005	-0.0019	-0.0040	0.0134	0.0145	0.0222
2006	0.0056	0.0067	-0.0061	0.0151	0.0213
Contribution	0.0841	0.0432	0.3722	0.5004	1.0000
3. POE					
2000	-0.0132	-0.0004	0.0154	0.0141	0.0160
2001	0.0160	-0.0037	0.0019	-0.0032	0.0110
2002	0.0054	0.0010	0.0113	0.0112	0.0289
2003	0.0048	0.0001	0.0168	0.0149	0.0366
2004	0.0189	-0.0013	0.0364	0.0188	0.0728

2005	0.0013	0.0020	-0.0158	0.0003	-0.0123
2006	0.0025	0.0006	0.0072	0.0298	0.0402
Contribution	0.1851	-0.0090	0.3788	0.4448	1.0000
4. HMT					
2000	0.0050	0.0045	-0.0017	0.0134	0.0213
2001	0.0045	0.0035	-0.0070	0.0026	0.0036
2002	0.0000	0.0012	0.0181	0.0212	0.0406
2003	0.0004	0.0041	0.0055	0.0177	0.0277
2004	-0.0087	0.0090	0.0285	0.0745	0.1033
2005	0.0009	0.0047	-0.0088	-0.0051	-0.0084
2006	-0.0039	0.0085	-0.0120	0.0316	0.0243
Contribution	-0.0082	0.1675	0.1063	0.7345	1.0000
5. NHMT					
2000	-0.0128	0.0017	0.0001	0.0352	0.0242
2001	0.0017	0.0016	0.0253	-0.0066	0.0219
2002	-0.0017	0.0011	0.0064	0.0304	0.0362
2003	-0.0054	0.0058	0.0050	0.0336	0.0390
2004	-0.0091	0.0070	0.0183	0.0913	0.1074
2005	-0.0086	0.0012	0.0066	0.0123	0.0116
2006	-0.0074	0.0010	-0.0164	0.0456	0.0228
Contribution	-0.1645	0.0734	0.1721	0.9188	1.0000

<Table 6> Summary Statistics for spillover variables

Variable	Mean	S.D.	Min	Max
Old_hori_HMT	0.126	0.103	0	0.493
Old_forw_HMT	0.027	0.015	0.003	0.064
Old_back_HMT	0.034	0.025	0	0.102
New_hori_HMT	0.003	0.004	0	0.021
New_forw_HMT	0.001	0.001	0	0.005
New_back_HMT	0.001	0.001	0	0.006
Old_hori_NHMT	0.148	0.126	0	0.725
Old_forw_NHMT	0.035	0.019	0.005	0.099
Old_back_NHMT	0.042	0.027	0	0.121
New_hori_NHMT	0.004	0.006	0	0.034
New_forw_NHMT	0.001	0.001	0	0.008
New_back_NHMT	0.001	0.001	0	0.006

<Table 7> Contemporaneous spillover effects of HMT and NHMT (Level)

	Level		First difference	
	HMT	NHMT	HMT	NHMT
Horizontal	0.82***	0.40***	0.57***	0.17***
	(0.00)	(0.00)	(0.00)	(0.00)
Forward	0.14***	1.45***	-0.08***	1.77***
	(0.01)	(0.01)	(0.01)	(0.02)
Backward	-0.33***	0.29***	-0.02**	0.78***
	(0.00)	(0.00)	(0.01)	(0.01)
HHI	-0.10***	0.02***	0.03***	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Region dummy	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
Constant	-0.15***	-0.25***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)
Number of obs.	1,056,005	911,161	676,500	499,115
Adj-R^2	0.70	0.71	0.18	0.13

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

<Table 8> Productivity spillovers from HMT and NHMT: Level and first difference

	Level		First difference	
	HMT	NHMT	HMT	NHMT
Old_horizontal	0.80***	0.54***	0.44***	0.33***
	(0.00)	(0.00)	(0.00)	(0.00)
Old_forward	-1.54***	2.23***	0.09***	0.81***
	(0.02)	(0.01)	(0.02)	(0.02)
Old_backward	-0.38***	-0.74***	-0.65***	-0.41***
	(0.01)	(0.01)	(0.01)	(0.01)
New_horizontal	6.47***	0.18***	7.48***	-0.80***
	(0.05)	(0.03)	(0.03)	(0.03)
New_forward	23.40***	-10.55***	3.99***	5.66***
	(0.30)	(0.10)	(0.20)	(0.16)
New_backward	0.46***	35.13***	21.24***	31.08***
	(0.18)	(0.20)	(0.16)	(0.21)
HHI	-0.11***	0.09***	0.03***	0.09***
	(0.00)	(0.00)	(0.00)	(0.00)
Region dummy	Yes	Yes	Yes	Yes
Industry dumnny	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
Constant	-0.13***	-0.24***	-0.00***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)
Number of obs.	1,056,005	911,161	676,500	499,115
Adj-R^2	0.71	0.73	0.24	0.19

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.0$

<Table 9> Comparison of HMT and NHMT's spillover effects

	Level	First Difference
Old_horizontal_HMT	0.27***	0.46***
	(0.00)	(0.01)
Old_forward_HMT	-12.76***	-4.96***
	(0.04)	(0.04)
Old_backward_HMT	0.19***	-2.04***
	(0.01)	(0.02)
New_ horizontal _HMT	15.31***	8.94***
	(0.06)	(0.04)
New_forward_HMT	35.43***	38.02***
	(0.39)	(0.28)
New_backward_HMT	11.92***	25.01***
	(0.22)	(0.17)
Old_horizontal_NHMT	0.41***	0.18***
	(0.00)	(0.00)
Old_forward_NHMT	7.46***	1.00***
	(0.02)	(0.03)
Old_backward_NHMT	-1.05***	0.27***
	(0.01)	(0.02)
New_horizontal_NHMT	-1.12***	-0.48***
	(0.03)	(0.03)
New_forward_NHMT	-8.51***	13.94***
	(0.14)	(0.16)
New_backward_NHMT	27.21***	19.61***
	(0.21)	(0.20)
HHI	-0.05***	0.07***
	(0.00)	(0.00)
Region dummy	Yes	Yes
Industry dummy	Yes	Yes
Year dummy	Yes	Yes
Constant	-0.12***	-0.01***
	(0.00)	(0.00)
Number of observations	911,159	499,112
Adj-R^2	0.77	0.32

<Table 10> Select statistics and characteristics of domestic firms acquired by HMT and NHMT sectors

HMT					NHMT				
Industry (CIC)	Sum of horizontal [a]	Domestic contents [b]	Exports/ Domestic Sales [a]	Technology level [c]	Industry (CIC)	Sum of horizontal [a]	Domestic contents [b]	Exports/ Domestic Sales [a]	Technology level [c]
21	0.120	0.824	2.210	low	14	0.184	0.749	0.069	low
18	0.088	0.584	1.745	low	19	0.112	0.740	3.875	low
24	0.074	0.920	2.522	low	27	0.112	0.828	0.102	high
19	0.067	0.740	1.747	low	24	0.106	0.920	3.103	low
42	0.064	0.908	2.005	low	15	0.093	0.940	0.043	low
20	0.056	0.590	0.471	low	40	0.082	0.585	3.733	high
28	0.052	0.846	0.071	Med-high	34	0.057	0.455	1.211	Med-low
41	0.045	0.838	2.001	high	41	0.051	0.838	3.227	high
39	0.045	0.727	0.783	Med-high	32	0.049	0.727	0.117	Med-low
27	0.043	0.828	0.127	high	18	0.045	0.828	1.471	low

a. Author's calculations. Sum of horizontal is calculated summing up $Horizontal_{jt} = \left[\sum_{i \text{ for all } i \in j} FShare_{it} * Y_{it}\right] / \sum_{i \text{ for all } i \in j} Y_{it}$, of each industry j for t=1998~2007. The value represents relative size of share of foreign affiliates' output to total industry output.
b. Kamal (2015), Table A2 on p.311. Domestic content represents the domestic value added in the production process.
c. Jeon et al. (2013), Table 1 on p.108. It is divided based on technology intensity following the OECD classification of industries by required technological level (OECD, 2005).

Appendix

A1. Data treatment explanation.

We clean the sample by using strict criteria. First, we drop firms with an annual revenue below 500 million RMB and observations with missing values for sales, output, employment, fixed assets, net fixed assets, and total assets. Second, we drop observations with fewer than eight employees because these small firms may not have reliable accounting systems, as Brandt et al. (2012) suggest. Third, we drop observations that apparently violate accounting principles: liquid assets, fixed assets, or net fixed assets larger than total assets. Fourth, we drop observations with invalid time records (e.g., the opening month is later than December or earlier than January, the opening year is larger than the observed year) and those with inception dates earlier than 1949.

We delete firms that reported different founding years almost every year in the annual surveys. Considering some firms may have accidentally filled in the wrong year, we use the founding year that was reported most often as the firm's founding year. We adjust the founding year to more accurately measure firms' real capital, because the founding year is used to estimate real capital, as suggested by Brandt et al. (2012) and Berkowitz et al. (2017).

Finally, we trim the top 1% and bottom 1% of TFP for each year to remove the effects of outliers. Among them, 49,048 firms changed their ownerships once, 2,204 firms twice, 82 firms three times, and one firm for four times. In a later analysis, we focus on firms with one ownership change. For further information, see Brandt et al. (2014).

<Table A> List of 2-digit CIC codes

Industry codes	Description
13	Processing of food from agric. Products
14	Manufacture of foods
15	Manufacture of alcohol, beverages, and refined tea
16	Manufacture of tobacco
17	Manufacture of textiles
18	Manufacture of textiles, clothing; apparel industry
19	Manufacture of leather, fur, feather and related products; footwear industry
20	Processing of timber, manufacture of wood, bamboo, rattan, palm, and straw products
21	Manufacture of furniture
22	Manufacture of paper and paper prod.
23	Printing and recorded media
24	Manufacture of articles for culture, education, art, sports, and entertainment
25	Processing of petroleum, coking, processing of nuclear fuel
26	Manufacture of chemical raw materials and chemical products
27	Manufacture of medicines
28	Manufacture of chemical fibers
29	Manufacture of rubber
30	Manufacture of plastics
31	Manuf. of non-metallic mineral products
32	Smelting and processing of ferrous metals

33	Smelting and processing of non-ferrous metals
34	Manufacture of metal products
35	Manufacture of general purpose machinery
36	Manufacture of special purpose machinery
37	Manufacture of automobiles
39	Manufacture of railway, ships, aerospace and other transportation equipment
40	Manufacture of computers, communication and other electronic equipment
41	Manufacture of measuring instruments
42	Handicrafts and Other manufacturing

<Table B> Regions represented by the regional dummy variables of equation (3).
Regions are designated as comprising of the following groups of provinces and municipalities-
(i) Coastal: Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangzhou, Hainan;
(ii) Inland: Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan;
(iii) Northeast: Liaoning, Jilin, Heilongjiang;
(iv) Northwest: Inner Mongolia, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang;
(v) Southwest: Guangxi, Chongqing, Sichuan, Guizhou, Yunnan.