Do Institutions Matter for FDI Spillovers?

The Implications of China's "Special Characteristics"

Luosha Du[1], UC Berkeley

Ann Harrison[2], World Bank, UC Berkeley and National Bureau of Economic Research

Gary Jefferson, Brandeis University

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Abstract

A number of recent studies examine the spillovers of foreign direct investment (FDI) on China's domestic industrial enterprises. This study goes further by investigating the implications of institutions for the nature of spillovers during 1998-2007. We examine three institutional features that comprise aspects of China's "special characteristics": (1) the different sources of FDI, where FDI is nearly evenly divided between mostly Organization for Economic Co-operation and Development (OECD) countries and the region known as "Greater China", consisting of Hong Kong, Taiwan, and Macau; (2) China's heterogeneous ownership structure, involving state- (SOEs) and non-state owned (non-SOEs) enterprises; and (3) industrial promotion via tariffs or through tax holidays to foreign direct investment. We find positive and significant linkages to domestic firms via horizontal foreign investment, forward linkages (the contacts between foreign affiliates and their local clients in downstream sectors) and backward linkages (the contacts between foreign buyers and local suppliers). Our results suggest varied success with industrial promotion policies. Final goods tariffs as well as input tariffs are negatively associated with firm-level productivity. However, we find statistically significant evidence of stronger productivity spillovers associated with firms that received tax breaks, suggesting that tax holidays were more successful than tariffs as an instrument to promote productivity growth in China.

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[1] Ph.D. candidate, Department of Agricultural and Resource Economics, University of California, Berkeley, 310 Giannini Hall, #3310, Berkeley, 94720-3310. Email: luosha@berkeley.edu

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[2] World Bank, 1818 H Street, N.W. 20433 Email: aharrison2@worldbank.org

I. Introduction

Since opening its economy to the outside world in late 1978, China has absorbed an increasing amount of FDI. It is now among the world's largest hosts for foreign investment, and has consistently ranked number one as the largest developing country recipient of FDI inflows in recent years. Potential technology transfer is likely to have been an important rationale behind the Chinese government's aggressive efforts over the past two decades to attract foreign investment to China (Hu and Jefferson, 2002). Indeed, the Chinese government has intervened extensively to promote industrialization in China, relying on a range of policy instruments. These instruments include tariffs, tax subsidies, and promotion of foreign investors in key sectors.

One typical justification for subsidizing incoming foreign investment is an externality in the form of technology spillovers. Technology spillovers can be defined to take place when the entry or presence of multinationals increases the productivity of domestic firms as the multinationals do not fully internalize the value of these benefits. We define intra-industry spillovers (also called horizontal spillovers) as occurring when domestic firms are affected by foreign corporations located in the same sector, while inter-industry spillovers (vertical spillovers) occur when domestic firms are affected by foreign firms in the upstream (forward linkage) or downstream sectors (backward linkages).

There have been a number of recent papers that test for technology spillovers from foreign investment. Most of these studies, such as papers by Haddad and Harrison (1993) on Morocco, Aitken and Harrison (1999) on Venezuela, and Konings (2001) on Bulgaria, Romania and Poland, either failed to find evidence of horizontal spillovers or reported negative horizontal spillover effects. More recently, Javorcik (2004) argued that since multinationals may simultaneously have an incentive to prevent information leakage that would enhance the performance of their local competitors, while at the same time perhaps benefitting from transferring knowledge to their local suppliers or clients, spillovers from FDI are more likely to be negative along the horizontal dimension and positive along the vertical dimension. Javorcik uses firm-level data from Lithuania to show that positive FDI spillovers take place through backward linkages (between foreign affiliates and their local suppliers in upstream sectors); however, there is no robust evidence of positive spillovers occurring through either the horizontal or the forward linkage channel. One recent manuscript that investigates both horizontal and vertical FDI spillovers in China is Lin, Liu, and Zhang (2008). In contrast to Javorcik (2004), Lin, Liu, and Zhang find evidence of forward positive spillovers, but no significant backward linkages.

There are also a set of theoretical studies demonstrating that positive FDI spillovers are more likely to operate at the inter-industry rather than the intra-industry level. For instance, there are studies on the choice by multinationals to use FDI as a model of market penetration. These studies emphasize efforts to minimize the probability of imitation, especially under imperfect intellectual property rights in the host country. As Markusen and Venables (1998) point out, proximity to potential domestic competitors with absorptive capacity to reverse engineer proprietary technology would be detrimental to a multinational, thus motivating it to set up its subsidiaries where potential rivals cannot erode its market share. By contrast, the multinational can benefit from knowledge diffusion when it reaches downstream clients and upstream suppliers, which will encourage vertical flows of generic knowledge that lead to inter-industry spillovers.

This study goes further by investigating the implications of the institutional context for the nature of spillovers. In particular, we examine three institutional features that comprise aspects of China's "special characteristics": the different sources of FDI, which are nearly evenly divided between mostly OECD countries and the region sometimes referenced as "Greater China" (Hong Kong, Taiwan and Macau); China's extraordinarily heterogeneous ownership structure, involving state and non-state ownership, and tax incentives such as income tax subsidies. Many foreign investors in China over the last ten years have faced much lower corporate tax rates; before 2008, foreign investors received 15 percent corporate tax rate while domestic enterprises faced a regular 33 percent corporate tax rate[3]. This policy of promoting foreign investors and other favored firms in China was only discontinued in 2008.

In addition to exploring the differential effects of foreign investment linkages across special characteristics in explaining productivity performance, we also control for the impact of intermediate and final good tariffs. Until 1990, average tariffs on manufacturing in China were as high as 50 percent. There is a rich literature which examines the impact of trade liberalization on productivity, although there are fewer studies that disentangle the effects of input and output tariffs. One example is Amiti and Konings (2007), who use Indonesia manufacturing census data to show that the effect of reducing input tariffs significantly increases productivity, and that this effect is much higher than reducing output tariffs. For China, Brandt, Biesebroeck and Zhang (2008) focus specifically on the impact of trade liberalization on productivity. Using Chinese firm-level data (1998-2005), they suggest that a ten percentage point reduction in final good output tariffs results in an increase in TFP of 0.42 percent.

Our results suggest varied outcomes from promoting domestic productivity growth through these different instruments. The benefits via vertical linkages from foreign investment have been significant and positive, but the impact of tariffs on total factor productivity growth has been negative. We find significant horizontal externalities from foreign direct investment (FDI), as well as strong evidence of positive and significant vertical linkages to domestic firms via forward linkages (the contacts between foreign affiliates and their local clients in downstream sectors) and backward linkages (the contacts between foreign buyers and local suppliers). Unlike previous studies on foreign investment in China, we find strong evidence of

[3] However, the government adjusted this preferential policy in 2008. Starting from Jan 1, 2008, the new corporate tax policy for foreign-invested firms is the following: foreign-invested firms that previously receive preferential corporate tax rates will return to the regular tax rate within 5 years. In 2008, the tax rate increases from 15% to 18%; in 2009, the rate keeps increasing to 20%; in 2010, the corporate tax rate is 22% and will finally reach 25% in 2012.

backward linkages as well as forward linkages. One reason for our finding may be that previous studies did not have sufficiently differentiated sector level price deflators; our evidence suggests that foreign firms have exerted significant downward pressure on prices through vertical linkages, which would appear as lower vertical productivity effects if not properly accounted for.

Firm ownership and sources of FDI significantly affect the magnitude of FDI spillovers. After we recalculate sector-level FDI based on its origin[4], we find that investors from "Greater China" and those from the rest of the world, largely the OECD region, generate completely different horizontal linkages for domestic firms. That is, OECD investors do help domestic firms located in the same industry whereas investors from the region of "Great China" hurt their domestic counterparts or have no impact.

For trade policy, our results suggest a negative, significant effect of final goods tariffs on domestic productivity growth. We also test for the effects of input tariffs on productivity, and find negative and significant effects of input tariffs on productivity growth. Finally, we explore the rationale for tax subsidies bestowed on foreign investors. If the Chinese government correctly targets, through tax concessions, those firms with greater potential for externalities, we would expect stronger linkages associated with tax breaks. We find statistically significant evidence of stronger productivity externalities associated with firms that received tax breaks.

Our empirical strategy follows Javorcik (2004) and Olley and Pakes (1996) (henceforth OP). First, we use Javorcik's (2004) empirical strategies to calculate *Backward* and *Forward* linkages and follow her estimation models to test whether there are vertical FDI spillovers in the manufacturing sector in China. We address the endogeneity of inputs by applying the strategy proposed by OP. We also apply a variety of specifications to take into account firm-specific fixed effects, and find that

[4] This means that we will have two sets of sector-level FDI variables. One of them is calculated based on foreign investment contributed by Hong Kong, Taiwan and Macau investors and the other set is obtained based on foreign assets provided by investors from outside the "Greater China" region. Because these other investors are largely located in the EU, North America, Japan, and S. Korea, we refer to this other FDI sources as "OECD" foreign investment.

our results are robust to these alternative approaches.

The rest of paper is organized into five further sections. Section II describes the basic framework and the data used in this paper and review broad trends for the 1998 through 2007 period. Section III discusses the econometric issues and presents the empirical results. Section IV concludes.

II. Basic Framework and Data

Section II.A describes the analytical framework, estimation equation, and measures for constructing the key spillover variables that we use. Section II.B describes the key features of our firm-level panel data set and the summary statistics for our sample period.

A. Basic Framework

To examine the impact of intra- and inter-industry FDI spillovers and trade policy across various institutional dimensions on firm productivity, we employ the following basic model, inspired by Aitken and Harrison (1999) and Javorcik (2004):

$$\ln Y_{ijt} = \alpha + \beta_1 \ln K_{ijt} + \beta_2 \ln L_{ijt} + \beta_3 \ln M_{ijt} + \beta_4 ForeignShareHKTM_{ijt} + \beta_5 ForeignShareFR_{ijt} + \beta_6 StateShare_{ijt} + \beta_7 Horizontal_{jt} + \beta_8 Backward_{jt} + \beta_9 Forward_{jt} + \alpha_i + \alpha_t + \varepsilon_{ijt} \quad (1).$$

Y_{ijt} is output value (quantities*prices) for firm i in sector j at time t, which is deflated by the sector-specific ex-factory price index of industrial products in order to separately identify quantity[5]. K_{ijt}, capital, is defined as the value of fixed assets, which is deflated by the fixed assets investment index, and L_{ijt} is the total number of employees. M_{ijt} represents the intermediate inputs purchased by firms to use for production of final products, which is deflated by the intermediate input price index.[6]

[5] Sector-specific ex-factory price indices for industrial products came from China Urban Life and Price Yearbook (2008, Table 4-3-3). The price indices are published for 29 individual sectors.
[6] Price indices for fixed investment and industry-wide intermediate inputs are obtained from the Statistical Yearbook (2006) (obtained from the website of the National Bureau of Statistics of China).

Foreign Share HKTM$_{ijt}$, *ForeignShareFR*$_{ijt}$ and *StateShare*$_{ijt}$ are defined as the share of the firm's total equity owned by Hong Kong-Taiwan-Macau investors, foreign investors, and the state respectively. By construction, these three firm-level controls are continuous variables and have a range from 0 to 1[7].

The motivation for separating foreign share into two types is two-fold. First, we would like to see whether some types of foreign investment are more likely to result in technology spillovers than others. Second, anecdotal evidence suggests large quantities of so-called foreign investors in China are actually domestic investors who channel investment through Hong Kong in order to take advantage of special treatment for foreign firms (so-called "round tripping"). If this is the case, then we would expect that foreign investment of this type might have a smaller impact on domestic firms.

Following Javorcik (2004), we define three sector-level FDI variables. 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 in sectoral output. In other words,

$$Horizontal_{jt} = \left[\sum_{i for all i \in j} ForeignShare_{it} * Y_{it} \right] / \sum_{i for all i \in j} Y_{it} \quad (2),,$$

where $ForeignShare_{it}$ is sum of $ForeignShareHKTM$ and $ForeignShareFR$. Second, *Backward*$_{jt}$, captures the foreign presence in the sectors that are supplied by sector j[8]. Therefore, *Backward*$_{jt}$ is a measure for foreign participation in the downstream industries of sector j. It is defined as

$$Backward_{jt} = \sum_{k if k \neq j} \alpha_{jk} Horizontal_{kt} \quad (3).$$

α_{jk} is taken from the 2002 input-output table[9] representing the proportion of sector j's production supplied to sector k. Finally, *Forward*$_{jt}$ is defined as the weighted

7 In some specifications, we run regressions with domestic firms only. In these cases, we use the sample of pure domestic firms, which have zero foreign investment. Then we regress either the log of the firm's output or productivity on sector-level FDI without the variable "Foreign Share".

8 For instance, both the furniture and apparel industries use leather to produce leather sofas and leather jackets. Suppose the leather processing industry sells 1/3 of its output to furniture producers and 2/3 of its output to jacket producers. If no multinationals produce furniture but half of all jacket production comes from foreign affiliates, the *Backward* variable will be calculated as follows: 1/3*0+2/3*1/2=1/3.

9 Input-ouput tables of China (2002) Table 4.2, which divides manufacturing industry into 71 sectors.

share of output in upstream industries of sector j produced by firms with foreign capital participation. As Javorcik 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. Thus, the following formula is applied:

$$Forward_{jt} = \sum_{m if m \neq j} \delta_{jm} \left[\left[\sum_{i for all i \in m} ForeignShare_{it} * (Y_{it} - X_{it}) \right] / \left[\sum_{i for all i \in m} (Y_{it} - X_{it}) \right] \right] \quad (4).$$

δ_{jm} is also taken from 2002 input-output table. Since $Horizontal_{jt}$ already captures linkages between firms within a sector, inputs purchased within sector j are excluded from both $Backward_{jt}$ and $Forward_{jt}$.

B. Data and Broad Trends

The data set employed in this paper was collected by the Chinese National Bureau of Statistics. The Statistical Bureau conducts an annual survey of industrial plants, which includes manufacturing firms as well as firms that produce and supply electricity, gas, and water. It is firm-level based, including all state-owned enterprises (SOEs), regardless of size, and non-state-owned firms (non-SOEs) with annual sales of more than 5 million yuan. We use a ten-year unbalanced panel dataset, from 1998 to 2007. The number of firms per year varies from a low of 162,033 in 1999 to a high of 336,768 in 2007. The sampling strategy is the same throughout the sample period (all firms that are state-owned or have sales of more than 5 million RMB are selected into the sample); the variation of numbers of enterprises across years may be driven by changes in ownership classification or by increases (or reductions) in sales volume in relation to the 5 million yuan threshold. However, the data show that 5 million yuan is not a strict rule. Among non-SOEs, about 6 percent of the firms report annual sales of less than 5 million yuan in 1998; this number rises to 8 percent by 1999 and falls after 2003. In 2007, only 1 percent of non-SOEs have annual sales below 5 million RMB. In terms of the full sample, the percent of firms with sales less than 5 million RMB stays at the same level for 1998 and 1999 and starts falling in 2000. In 2007, around 2 percent of the sample consists of firms with annual sales less than 5 million yuan.

The original dataset includes 2,226,104 observations and contains identifiers that can be used to track firms over time. Since the study focuses on manufacturing firms, we eliminate non-manufacturing observations. The sample size is further reduced by deleting missing values, as well as observations with negative or zero values for output, number of employees, capital, and the inputs, leaving a sample size of 1,842,786. Due to incompleteness of information on official output price indices, three sectors are dropped from the sample[10]. Thus, our final regression sample size is 1,545,626.

The dataset contains information on output, fixed assets, total workforce, total wages, intermediate input costs, foreign investment, Hong Kong-Taiwan-Macau investment, sales revenue, and export sales. These are the key variables from which we obtain measures of firm-level foreign asset shares and the FDI spillover variable, which are discussed in detail in the next section. In this paper, to test the impact of FDI spillovers on domestic firm productivity, we use the criterion of zero foreign ownership to distinguish domestic firms and foreign owned firms, that is, domestic firms are those with zero foreign capital in their total assets[11]. In the dataset, 1,197,597 observations meet the criterion[12].

Table 1 reports the summary statistics for the main variables used in the regressions. The statistical means highlight the remarkable growth rates exhibited by the manufacturing sector during this period, with average output growing 13.5 percent a year, and the net capital stock growing 10.7 percent per year. Labor input grew significantly slower, with average annual increases of only 1.3 percent per year. The means also document that on average foreign-invested assets have been almost evenly split between sources in Hong Kong, Taiwan, and Macau ("HKTM"), and

[10] They are sectors of processing food from agricultural products; printing, reproduction of recording media; and general purpose machinery.

[12] Actually, the international criterion used to distinguish domestic and foreign-invested firms is 10%, that is, the share of subscribed capital owned by foreign investors is equal to or less than 10%. In the earlier version of the paper, we tested whether the results are sensitive to using zero, 10%, and 25% foreign ownership. Our results show that between the zero and 10% thresholds, the magnitude and the significance levels of the estimated coefficients remain close, which makes us comfortable using the more restrictive sample of domestic firms for which the foreign capital share is zero. The results based on the 25% criterion exhibit small differences; the discussion on sensitivity analysis is beyond the scope of this paper.

foreign investment originating in other locations. The state continues to play an important role in manufacturing, with a mean asset share of 8.9 percent during the sample period; over the sample period the share of total foreign investment in manufacturing is significantly larger, at 16.8 percent. The average state share during this period fell by approximately .7 percentage point per year.

In Tables 2-1, 2-2, 2-3, and 2-4, we provide summary statistics for the four sets of spillover variables. The share of foreign-invested assets at the sector level, i.e., the horizontal foreign share, increased over the sample period, from 20.4 to 26.7 percent. To take into account the sources of FDI for sectoral spillovers, we re-calculate sector-level FDI variables from two broad geographic categories. To explore the importance of the source of foreign investment within the firm for productivity, we calculate firm-level foreign investment, horizontal foreign shares, and vertical foreign shares for both Hong Kong, Taiwan, and Macau FDI, and for foreign investment originating in other locations, i.e. principally the OECD countries. Table 2-2 shows basic summary statistics for these two sets of sectoral spillover variables. The basic summary statistics show that the two sets have exhibited different trends over time. FDI shares for Hong Kong, Taiwan, and Macau investment steadily increased over the period of 1998-2003. In contrast, FDI from other regions shows an even faster and steadily increasing pattern of growth over the entire time period. It is clear from Tables 2-2 that most of the increase in foreign investment over 1998-2007 originated outside of Hong Kong, Taiwan, and Macau.

Table 2-3 reports trends in subsidized and non-subsidized foreign investment. While the standard tax rate across all firms during the sample period was 33 percent, a large share of foreign-owned firms were granted tax subsidies, thus facing tax rates that were significantly lower. In the left three columns of Table 2-3, we redefine our sector-level foreign share variables by restricting them to only those foreign firms who paid less than the statutory tax rate. In the right three columns of Table 2-3, we redefined sector-level foreign share to restrict it to those firms who paid the full rate. The trends show a steady increase in subsidized foreign investment between 1998 and 2007. By the end of the sample period, the majority of foreign investors received some form of a tax subsidy.

Table 2-4 reports the percentage of firms who were subsidized based on value-added taxes, which are reported separately from income taxes on profits. Fewer firms receive subsidies in the form of exemptions on value-added taxes. These exemptions increased until 2003, then declined. It is clear from these tables that income tax holidays were a more pervasive form of incentives until the 2008 tax reform.

III. Estimation and Results

A. Baseline Results

We begin the analysis by estimating the model described in equation (1) using ordinary least square (OLS) with and without firm fixed effects. Columns (1) and (2) of Table 3 are estimated with the dependent variable as the log of the firm's deflated output. To study the impact of FDI spillovers on the performance of domestic firms, we are interested in how FDI invested in other firms affect the domestic firms located in the same sector. Therefore, the key parameters in the above specification are β_7, β_8 and β_9.

One possibility that has not been explored in the literature on vertical and horizontal linkages is that foreign investment shares are proxying for different trade policies across sectors. Protected sectors may be more likely to receive foreign investment as these firms may be motivated to relocate in order to circumvent tariff or non-tariff barriers ("tariff-jumping" foreign investment, which leads to immiserizing effects as modeled by Diaz Alejandro (1977)). In this case, the gains from foreign investment could be under-estimated due to omitted variable bias.

To control for the effects of trade policies, we have created a time series of tariffs, obtained from the World Integrated Trading Solution (WITS), maintained by the World Bank. We aggregated tariffs to the same level of aggregation as the foreign investment data, using output for 2003 as weights. We also created forward and backward tariffs, to correspond with our vertical FDI measures. Table 1 and

Table A-4 show basic summary statistics for these tariff variables. During the sample period, average tariffs fell nearly 9 percentage points, which is a significant change over a short time period. While the average level of tariffs during this period, which spans the years before and after WTO accession, was nearly 13 percent, this average masks significant heterogeneity across sectors, with a high of 41 percent in grain mill products and a low of 4 percent in railroad equipment.

We initially pool the data to include both firms with and without foreign investment, reporting results with and without firm fixed effects. The first column of Table 3, with the application of fixed effects, shows that firm productivity levels are higher for firms with participation from other (OECD) investors than those from Hong Kong, Taiwan, and Macao, and lower for firms with state-owned assets. There are no significant horizontal spillovers, but backward vertical linkages are positive and statistically significant. Final goods tariffs are negative and significantly associated with productivity.

Comparing the fixed effects results in the first column with the second column (where firm fixed effects are omitted), the results are consistent across the two specifications. As expected, the coefficient on capital's output elasticity is attenuated with the fixed effect estimator. While foreign-invested firms are much more efficient and state-invested enterprises are much less efficient than the non-state-domestically-invested enterprises that represent the reference, once firm fixed effects are controlled for the differences are much smaller. Such differences suggest important differences between productivity levels and growth rates of state owned and foreign enterprises versus other types of enterprises.

The third and fourth columns of Table 3 compare OLS and fixed effect estimates for the entire sample using Olley and Pakes (1996) to correct for the potential endogeneity of input choice. The earlier literature on production function estimation shows that the use of OLS is inappropriate when estimating productivity, since this method treats labor, capital and other input variables as exogenous. As Griliches and Mairesse (1995) argue, inputs should be considered endogenous since they are chosen by a firm based on its productivity. Firm-level fixed effects will not solve the problem, because time-varying productivity shocks can affect a firm's input decisions.

Using OLS will therefore bias the estimations of coefficients on the input variables. To solve the simultaneity problem in estimating a production function, we employ the procedure suggested by Olley and Pakes (1996) (henceforth OP), which uses investment as a proxy for unobserved productivity shocks. OP address the endogeneity problem as follows. Let us consider the following Cobb-Douglas production function in logs:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \omega_{it} + \varepsilon_{it} .$$

y_{it} , k_{it} , l_{it} , and m_{it} represent log of output, capital, labor, and materials, respectively. ω_{it} is the productivity and ε_{it} is the error term (or a shock to productivity). The key difference between ω_{it} and ε_{it} is that ω_{it} affects firm's input demand while the latter does not. OP also make timing assumptions regarding the input variables. Labor and materials are free variables but capital is assumed to be a fixed factor and subject to an investment process. Specifically, at the beginning of every period, the investment level a firm decides together with the current capital value determine the capital stock at the beginning of the nest period, i.e.

$$k_{it+1} = (1-\sigma)k_{it} + i_{it} .$$

The key innovation of OP estimation is to use firm's observable characteristics to model a monotonic function of firm's productivity. Since the investment decision depends on both productivity and capital, OP formulate investment as follows,

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

Given that this investment function is strictly monotonic in ω_{it}, it can be inverted to obtain

$$\omega_{it} = f_t^{-1}(i_{it}, k_{it}) .$$

Substituting this into the production function, we get the following,

$$\begin{aligned} y_{it} &= \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + f_t^{-1}(i_{it}, k_{it}) + \varepsilon_{it} \\ &= \beta_l l_{it} + \beta_m m_{it} + \phi_t(i_{it}, k_{it}) + \varepsilon_{it} \end{aligned}.$$

In the first stage of OP estimation, the consistent estimates of coefficients on labor and materials as well as the estimate of a non-parametrical term (ϕ_t) are obtained. The second step of OP identifies the coefficient on capital through two important assumptions. One is the first-order Markov assumption of productivity, ω_{it} and the timing assumption about k_{it}. The first-order Markov assumption decomposes ω_{it} into its conditional expectation at time *t*-1, $E[\omega_{it} \mid \omega_{it-1}]$, and a deviation from that expectation, ζ_{it}, which is often referred to the "innovation" component of the productivity. These two assumptions allow it to construct an orthogonal relationship between capital and the innovation component in productivity, which is used to identify the coefficient on capital.

The biggest disadvantage of applying the OP procedure is that many firms report zero or negative investment. To address this problem, we also explore the robustness of our results to using the Levinsohn Petrin (2003) approach. With the Olley and Pakes correction, we can get an unbiased estimate of the firm's productivity. Therefore, the independent variable then becomes total factor productivity (TFP) instead of the log of output. Specifically, this is a two-stage estimation when using TFP as the dependent variable. The first step is to use OP to obtain unbiased coefficients on input variables and then calculate TFP (residual from the production function). The second step is to regress TFP on firm-level controls and FDI variables.

Moulton showed that in the case of regressions performed on micro units that also include aggregated market (in this case industry) variables, the standard errors from OLS will be underestimated. As Moulton demonstrated, failing to take account of this serious downward bias in the estimated errors results in spurious findings of the statistical significance for the aggregate variable of interest. To address this issue, the standard errors in the paper are clustered for all observations in the same industry.

As a robustness check, we also employed the procedure suggested by Levinsohn and Petrin (2003), which uses intermediate inputs as a proxy for unobserved productivity shocks. With LP's correction, the estimation procedure is also two-stage. In the first stage, we obtain input shares and calculate the firm's total factor productivity (TFP) (i.e., the residuals from production function). In the second stage, we regress TFP on the remaining independent regressors in this initial specification. However, to save on space we only report the results using the OP, and not the LP procedure. The results are qualitatively similar using both approaches.

The results in the last two columns of Table 3 present the pooled estimates using the OP method. The primary sector-level variables of interest are generally unaffected. Before discussing in more detail the magnitudes of the coefficients, including the implications of using the OP method for the magnitudes of the factor input coefficients, we divide the sample across ownership categories. In particular, Table 3 pools both domestically-invested and foreign-invested firms. Consequently, we cannot distinguish between spillovers to domestic firms or cluster effects for foreign enterprises. In all the results which follow, we separate firms into foreign-invested firms—those with some positive foreign ownership—and domestically-owned firms—defined as enterprises with zero foreign ownership.

The baseline results, which incorporate the firm fixed effect specification used in the first and third columns of Table 3, are presented in Table 4. Comparing the results across three different samples (all, foreign-invested, and domestic firms) shows differences in the patterns of FDI spillovers across different groups. Horizontal spillovers are significant only for domestic firms. Backward linkages are large in magnitude and positive for domestic firms, indicating that domestic enterprises benefit from foreign investors through acting as suppliers to foreign firms. Foreign-invested enterprises benefit from other foreign investment through both backward and forward linkages, indicating benefits to foreign firms from purchasing inputs from other foreign firms. The magnitude of the vertical linkages are generally larger for foreign-invested firms, suggesting that firms with foreign participation are even more likely to benefit from being near other foreign firms.

The F-tests listed at the bottom of the Table 4 identify whether these small differences are in fact statistically significant. As reported in the F-tests, the magnitudes are significantly larger for foreign-invested firms vis-à-vis forward linkages but not significantly different with regards to backward linkages. This implies that foreign firms benefit more than domestically-invested firms from interacting with upstream foreign suppliers. Due to these significant differences, in the rest of the paper we separately report the effects of horizontal and vertical spillovers on firms according to their degree of foreign asset participation.

Our results show that positive externalities are operating via both horizontal, forward and backward linkages. The positive forward linkages imply that enterprises benefit from foreign firms that are upstream to their operations. The evidence is also consistent with strong backward linkages, suggesting that enterprises benefit from foreign firms that are downstream, who may use domestic firms as input suppliers.

Our results differ significantly from Javorcik (2004) and other studies of vertical linkages through foreign investment; all previous studies find significant and positive coefficients for "*Backward*" but not for "*Forward*", and they explain that the vertical spillovers occurred through contracts between multinational consumers and domestic suppliers. In our case, an additional linkage occurs—vertical spillovers take place through contracts between domestic demanders and multinational suppliers as well.

One possible explanation is that the foreign participation in the upstream sectors may increase the variety of inputs and provide more sources of inputs to the downstream firms and thus lead to a higher productivity in downstream firms. Ethier (1982) provides theoretical support for this argument, showing that access to a greater variety of inputs results in a higher productivity of downstream industries. Arnold, Javorcik and Mattoo (2008) also show that FDI can improve the performance of downstream firms by increasing the range of intermediate inputs available. Since costs of intermediate inputs account for a much larger share of output than is typically the case in other countries, it is not surprising that access to lower cost or higher quality inputs has such a significant impact on domestic firm productivity.

Backward linkages are also significant. We cannot distinguish between productivity increases that occur when domestic firms learn to comply with the higher standards for the goods and services required by multinationals, from the additional competition that leads to lower prices when foreign suppliers enter the input market. In any case, the technological gap between domestic firms and foreign enterprises that might have created a significant barrier for effective technological diffusion, limiting the establishment of backward linkage between domestic firms and multinationals and also constraining the absorbability of local firms, seems not to be a problem for the firms in our sample.

While Javorcik (2004) found evidence of backward linkages for Lithuania, previous efforts to identify backward linkages for China have been unsuccessful. In contrast, we find evidence of highly significant and large backward linkages. One possible reason may be that we are careful to deflate output with sector-level price deflators. To the extent that foreign investors induced additional competition among supplying enterprises, we would expect that foreign firms would have led to downward pressure on prices in those sectors where backward linkages are greatest. Without proper deflators, this would have appeared as falling productivity in those sectors, with falling prices being misinterpreted as falling output instead.

One way to test if this possibility is correct is to examine whether sector-level prices during the sample period were systematically related to foreign activity. Appendix Table A-3 shows that this is indeed the case. Price levels fell significantly in sectors where foreign firms exerted a significant downward pressure via backward linkages. This suggests that one important vehicle through which foreign firms played a key role was by exerting downward pressure on prices of domestic suppliers. The evidence on the competition effect induced by foreign firms on prices of input suppliers reported in Table A-3 is also useful in another respect. It illustrates the importance of using sector-specific price deflators (or prices) when identifying the spillovers from foreign investment, and explains why previous work on China failed to identify backward spillovers. Previous work did not take into account the lower prices associated with backward spillovers, which resulted in under-estimating the productivity gains since the lower prices and revenues were misinterpreted as lower productivity.

With the sample of all and domestic firms, the coefficient on the state's share in equity is negative and statistically significant, indicating that increases (decreases) in state-invested shares are associated with falling (increasing) productivity. The results on the state share are consistent with rising productivity for privatizing enterprises. The coefficients on the final goods tariff measures are generally negative and statistically significant. These results are somewhat different from Brandt et al. (2008), who fail to find a significant relationship between tariffs and total factor productivity for Chinese enterprises.

There are several reasons why the negative impact of input or final goods tariffs on productivity may be under-estimated. A large fraction of firms are granted exemptions from paying tariffs; without additional information on which firms are subjected to tariffs, it is difficult to identify the negative effect of tariffs on inputs. Second, average tariffs may be imposed for a number of reasons. If tariffs are successfully imposed in sectors where there are externalities in production, then the average effect of tariffs reflects both (beneficial) targeting and (harmful) disincentives associated with x-inefficiency. Third, to the extent that Melitz (1993) is correct, then many of the productivity gains associated with trade reform occur through reallocation of production towards more efficient firms, rather than within-firm productivity increases associated with greater exposure to international competition.

In Table A-2, we compare the coefficient estimates using OLS with firm fixed effects and the Olley-Pakes (1996) approach. Olley and Pakes (1996), as well as Levinsohn and Petrin (2003) predict, after implementing these two-stage procedures, that the coefficient on L should decrease, the coefficient on intermediate inputs should decrease and the coefficient on capital should increase. The results are generally consistent with these predictions across ownership classes. The coefficient on capital inputs is higher using OP across all specifications. We also generally find that the coefficient on the labor shares and material shares are lower with OP. What is unusual across all specifications is that the labor share is very low, compared to estimates for other countries. while the coefficient for input costs is very high. As a robustness check, we performed two tests. First, we calculated the share of labor expenditures in total output—the labor share in output according to the data. Under certain plausible restrictions (i.e., Cobb-Douglas production function, perfect competition) the coefficients on the factor inputs in our estimating equations should equal the factor shares. Imposing these restrictions, the estimate of labor's share over the sample period is around 10 percent, which is similar to the underlying OLS fixed effect estimates reported in Table A-2. Second, we compare the implied average wages from our sample (calculated by dividing total wages by the number of employees with average wages reported in the Chinese Statistical Yearbook for 1998 through 2007. The results are listed in Appendix Table A-1. From Table A-1, we can see that the average wages from the dataset are close to that from the statistical yearbook, although there are some differences. Consequently, we feel confident that the actual factor shares implied by the OLS and OP coefficient estimates are consistent with external evidence.

We note that while the coefficient estimates for our OLS fixed effect and OP specifications are plausibly close to the computed factor shares, this is only the case if one takes into account firm fixed effects in the estimation. In unreported results we model the fixed effect at the industry, and not the firm level, which yields OLS estimates with coefficient estimates which are even smaller for labor and implausibly high for material inputs. This bias is also evident if we compare the coefficient estimates with and without firm fixed effects, as reported in Table 3. We believe that this is the primary reason why the coefficient estimates presented in Lin, Lui, and Zhang (2008) are so different. Because they model the fixed effect at the industry and not the firm level, their labor coefficient is half the size of ours and their material input coefficient is significantly larger.

B. The Effects of Different Sources of Foreign Investment

In many FDI spillover studies, all domestic firms are assumed to benefit equally from FDI. However, different indigenous firms have varying absorptive capacities and the effectiveness of technology diffusion depends on technological capacities of indigenous firms as well as the characteristics of the foreign investors. To shed insight into the effect of this externality of FDI spillovers, we divide sector-level FDI variables into two groups based on their sources. The results are reported in Table 5.

The results point to significant and large differences in vertical as well as horizontal linkages which depend on the origin of the foreign investors. While horizontal linkages, which are not differentiated by country of ownership of the foreign investors, are sometimes insignificant, this average hides significant and contrasting effects. Horizontal linkages are negative but not significant for sectors with large shares of foreign investors originating in Hong Kong, Macao and Taiwan, suggesting that these firms act as competitors for domestically-owned firms. In contrast, horizontal linkages are positive and significant for sectoral foreign investment originating in other countries, suggesting that there are positive linkages within the same sector for foreign investment coming from further afield.

The results are also different for vertical linkages. There are strong, positive and significant backward and forward linkages for foreign investors originating outside of “Greater China”. These differences are statistically significant for horizontal and vertical forward linkages, as indicated by the formal tests of equality reported at the bottom of Table 5. These results point to clear differences in the pattern of technology transfer originating with foreign investment. Foreign firms coming from nearby regions act as competition in the same industry. Firms coming from further away are not direct competitors and convey positive horizontal and vertical externalities.

C. The Effect of State Ownership

In China, state-owned firms include firms that are formally classified as state-owned enterprises (SOEs), state-owned jointly operated enterprises and wholly state-owned companies. Non-state-owned enterprises (non-SOEs) include collectively- and privately-owned firms. Compared to non-SOEs, SOEs are typically larger and often technically competitive but less market-oriented; they face soft budget constraints and limited access to financial capital. Indigenous Chinese firms of different ownership typically behave differently with respect to imitation, innovation and competition, and have different technological capabilities for knowledge absorption from the presence of foreign firms (Li et al. 2001).

In Table 6, we divide the sample of all, foreign-invested, and domestic firms into two groups, SOEs and non-SOEs, to test whether the formal ownership structure and the composition of asset ownership matter for FDI spillover effects and trade policies. In columns (1) and (2), which present the results from OLS regressions with firm fixed effects, both enterprises with and without foreign equity participation are included in the analysis together. Columns (3) and (4) show the results using the sample of foreign-invested firms, and columns (5) and (6) present the results using the sample of purely domestic firms, defined as enterprises with zero foreign equity participation. All specifications allow for firm-specific effects and year effects.

The first two columns allow us to compare the impact of firm-level equity participation by foreign investors on the productivity of SOEs relative to non-SOEs. The coefficient on foreign participation from foreign investors outside of Greater China for SOEs is .098 relative to .0052 for non-SOEs. This suggests that foreign equity participation is associated with a difference in productivity which is twenty times greater for SOEs. The much larger and statistically significant coefficient associated with foreign equity participation in SOEs is consistent with the hypothesis that foreign firms have played an important role in improving the performance of some SOEs.

There is also evidence that SOEs benefit more from vertical linkages, as the magnitudes on backward as well as forward linkages are greater for SOEs. The coefficients exhibit a pattern of larger magnitudes for the SOEs, suggesting that foreign investment has played a particularly large role in transferring technology to SOEs, including those without foreign equity participation. The only exception is with horizontal spillovers. Horizontal spillovers are restricted to privately owned enterprises, suggesting that SOEs may not be able to benefit from firms in the same sector.

We also find different responses across SOEs and non-SOES to trade policy. Higher final goods tariffs are associated with significantly lower productivity for SOEs, relative to non-SOEs. The point estimates on final goods tariffs, which is -.0676 for SOEs with foreign investment and -.0519 for those with no foreign assets, suggests that a 1 percent fall in tariffs would increase productivity growth by .05 to .07 percent. Since average tariffs during the period fell over 10 percentage points (see Appendix), this suggests a gain in productivity of .5 to .7 percentage points associated on average with trade reforms for the SOEs. One possible interpretation of the larger effect of final goods tariffs on SOE performance is the greater importance of international competition for SOEs, which were traditionally supported by the government.

E. The Effects of Tax Incentives for FDI

We conclude this paper by exploring in Tables 7 and 8 the extent to which subsidized foreign investment is more likely to convey spillovers relative to unsubsidized foreign investment. While the standard tax rates across all firms during the sample period was 33 percent, a large share of foreign-owned firms were granted tax subsidies and faced tax rates that were significantly lower. Indeed, the means reported in Tables 2-3 and 2-4 suggest that the majority of foreign investment in China during the sample period benefited from income tax subsidies and a significant fraction benefited from subsidies on value-added taxes. To the extent that the Chinese government was able to target successfully firms more likely to convey positive externalities, we would expect different effects for these subsidized firms.

To test for this possibility, we split our sector-level foreign share variables into two groups: one is calculated based on foreign investment being subsidized (those paid less than the statutory tax rate)[13] and the other one is computed based on non-subsidized foreign investment. The results based on income tax incentives are presented in Table 7.

There is strong evidence that foreign firms receiving tax subsidies are more likely to generate positive externalities than other kinds of foreign firms. While the coefficients on backward linkages are positive, and statistically significant for foreign firms which received incentives in the form of lower income taxes, the coefficients on backward linkages for other types of foreign firms are negative. These differences are significant for backward linkages but not for forward or horizontal linkages, where the formal F-tests fail to reject that the effects are the same.

In Table 8, we test whether the results are different when we explore tax holidays on value-added taxes as a form of fiscal incentive instead. We define firms as subsidized when they were exempted from paying value-added taxes altogether. The results in Table 8 are consistent with differences in the effects of foreign investment based on income tax incentives. In particular, forward linkages are significantly stronger when the foreign investment received tax incentives in the form of exemptions on value-added taxes.

IV. Concluding Comments

[13] As discussed earlier, the statutory tax rate in China is 33%. However, foreign-invested firms receive a preferential tax break of 15%. In this paper, we use the cut-off of 20% to distinguish whether a foreign-invested firm is being subsidized.

In this paper, we explore the role played by foreign investors in generating technology transfer via horizontal and vertical linkages, as well as their role in promoting the reform of state enterprises through joint venture activity. We also explore the impact on productivity growth at the firm level of protection through tariffs and the selective imposition of tax subsidies to attract foreign investors.

Given the intensive interest in FDI as a vehicle through which developing countries learn about new technology, many firm-level studies have examined FDI spillovers. However, due to the lack of accessibility of firm-level data, few studies test for FDI spillovers in China. This paper, based on a rich firm-level dataset from China, tests particularly for vertical spillovers from FDI.. Taking account of the heterogeneity of sectoral FDI as well as the heterogeneity of firms' absorptive capacities, we explore different institutional factors in explaining the role of foreign investment in promoting technology transfer in China. We focus on three institutional factors in particular: the source of foreign investment, the structure of domestic firm ownership, and the role of tax subsidies.

Across a variety of specifications, and controlling for firm and year effects, we find that positive productivity spillovers from FDI take place through contracts between foreign affiliates and their local clients in upstream (backward) or downstream sectors (forward linkages). We also find evidence that positive productivity spillovers occur through horizontal foreign investment. The results for China are quite different compared to studies of vertical linkages that have been done for other countries. In other countries, there are typically only significant positive linkages through backward linkages.

We also highlight the different effects played by the sources of sectoral foreign direct investment on domestic firm productivity. While at the firm level foreign equity participation is generally associated with higher productivity, this is not the case for foreign equity participation that originates in Hong Kong, Macao, or Taiwan. There are several possible explanations for this. One major reason could be that such investments actually originate in China, and are simply rechanneled through nearby locations to take advantage of special incentives offered to foreign investors. Another possible explanation is that nearby foreign investors are not sufficiently different technologically.

Finally, we also take into account trade policies and tax policies. Controlling for differential tariffs across sectors is useful because some foreign investors may have invested in China in order to access protected domestic markets, which could have led to a bias in estimating the effects of foreign investment linkages on firm productivity. We find that tariffs are associated with negative and significant effects on firm productivity. Finally, we also explore the extent to which foreign investors who were targeted via special tax incentives generated different effects on domestic firms than others. We find significantly higher effects of targeted FDI on productivity growth relative to other kinds of FDI.

In several respects the Chinese experience has been different. Our results indicate that the institutional framework is critical for understanding the presence as well as the magnitude of such gains. The example of how foreign investment originating from Greater China, which includes Hong Kong, Macao, and Taiwan, is associated with zero spillovers, while foreign investment from other regions generates significant vertical and horizontal linkages is one vital example of the important role of this institutional analysis.

To our knowledge, this is the first study to examine whether fiscal incentives in the form of tax subsidies are associated with stronger linkages from foreign firms to domestic enterprises. We find strong evidence that subsidized foreign investment generates greater productivity spillovers than unsubsidized firms. Our future research will explore how different patterns of interventions are associated with productivity outcomes. Nunn and Trefler (2006) hypothesize that interventions oriented towards skill-intensive sectors are more likely to generate productivity growth, while Lin (2009) suggests that promotion of sectors where a country has a latent comparative advantage is more likely to be successful.

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Tables

Table 1 Summary Statistics for All Years, 1998-2007

	Number of observations	Mean	Std. Dev.	Number of observations	Mean	Std. Dev.
logY	1,545,626	10.015	1.343	1,086,616	0.135	0.563
logL	1,545,626	4.808	1.152	1,086,616	0.013	0.503
logK	1,545,626	8.468	1.719	1,086,616	0.107	0.753
logM	1,545,626	9.534	1.378	1,086,616	0.094	0.661
Foreign share (contributed by HK-Taiwan-Macau investors)	1,545,626	0.089	0.267	1,086,616	0.012	0.377
Foreign share (contributed by other investors)	1,545,626	0.079	0.249	1,086,616	0.0003	0.146
Stateshare	1,545,626	0.089	0.272	1,086,616	-0.007	0.147
Horizontal	1,545,626	0.254	0.142	1,086,616	0.004	0.046
Backward	1,545,626	0.077	0.046	1,086,616	0.002	0.015
Forward	1,545,626	0.103	0.173	1,086,616	0.004	0.066
Tariff	1,545,626	12.691	6.600	1,086,616	-0.869	2.295
Tariff_backward	1,545,626	8.191	3.769	1,086,616	-0.319	1.611
Tariff_forward	1,545,626	9.185	4.064	1,086,616	-0.359	2.066

Notes: We define firm-level foreign share according to its different sources. Foreign share contributed by HK-Taiwan-Macau is defined as the share of firms' total equity owned by investors from HK-Taiwan-Macau. Foreign share contributed by other countries is defined as the share of firms' total equity owned by investors outside HK-Taiwan-Macau, principally from OECD countries. State share is defined as the proportion of the firm's state assets to its total equity. Horizontal captures the intra-industry FDI spillover while backward and forward represent inter-industry FDI spillovers. We define horizontal, backward, and forward in equation (2), (3), and (4) respectively. The unit for the tariff variable is percentage.

Table 2-1 Summary Statistics for Spillover Variables

		Horizontal		Backward		Forward	
Year	Number of Observations	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1998	96,135	0.204	0.125	0.059	0.034	0.068	0.103
1999	104,253	0.220	0.132	0.066	0.038	0.077	0.120
2000	102,745	0.233	0.134	0.071	0.040	0.085	0.136
2001	114,735	0.240	0.135	0.071	0.041	0.089	0.142
2002	122,464	0.242	0.132	0.073	0.042	0.090	0.143
2003	138,377	0.250	0.139	0.075	0.044	0.099	0.166
2004	202,735	0.270	0.146	0.082	0.049	0.109	0.180
2005	194,274	0.273	0.149	0.083	0.049	0.117	0.199
2006	217,062	0.275	0.146	0.085	0.048	0.120	0.201
2007	255,042	0.267	0.143	0.083	0.048	0.119	0.199

Table 2-2 Summary Statistics for Spillover Variables that are calculated based on sources of FDI

Year	Number of Obs	Horizontal_HK		Backward_HK		Forward_HK		Horizontal_FR		Backward_FR		Forward_FR	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1998	96,135	0.097	0.068	0.026	0.015	0.033	0.037	0.059	0.069	0.033	0.021	0.037	0.059
1999	104,253	0.106	0.070	0.030	0.016	0.036	0.041	0.075	0.073	0.036	0.023	0.041	0.075
2000	102,745	0.112	0.072	0.033	0.018	0.038	0.048	0.089	0.077	0.038	0.024	0.048	0.089
2001	114,735	0.114	0.070	0.033	0.017	0.038	0.049	0.095	0.086	0.038	0.026	0.049	0.095
2002	122,464	0.112	0.070	0.032	0.018	0.041	0.052	0.097	0.082	0.041	0.026	0.052	0.097
2003	138,377	0.117	0.073	0.033	0.018	0.042	0.057	0.113	0.089	0.042	0.029	0.057	0.113
2004	202,735	0.116	0.067	0.034	0.019	0.048	0.065	0.126	0.102	0.048	0.033	0.065	0.126
2005	194,274	0.115	0.068	0.034	0.020	0.048	0.071	0.135	0.102	0.048	0.031	0.071	0.135
2006	217,062	0.114	0.067	0.034	0.019	0.051	0.074	0.144	0.104	0.051	0.032	0.074	0.144
2007	255,042	0.109	0.063	0.033	0.018	0.050	0.074	0.139	0.103	0.050	0.031	0.074	0.139

Table 2-3 Summary Statistics for Subsidized and non-Subsidized Spillover Variables (calculated based on income tax)

		Subsidized						Non-Subsidized					
		Horizontal		Backward		Forward		Horizontal		Backward		Forward	
Year	Number of Obs	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1998	96,135	0.076	0.060	0.022	0.015	0.024	0.047	0.112	0.068	0.033	0.018	0.038	0.050
1999	104,253	0.083	0.067	0.025	0.018	0.027	0.056	0.125	0.069	0.040	0.020	0.046	0.064
2000	102,745	0.096	0.072	0.029	0.020	0.033	0.070	0.130	0.070	0.041	0.021	0.049	0.068
2001	114,735	0.102	0.075	0.031	0.020	0.034	0.057	0.130	0.067	0.039	0.021	0.052	0.083
2002	122,464	0.107	0.080	0.035	0.025	0.041	0.091	0.128	0.066	0.037	0.018	0.047	0.059
2003	138,377	0.110	0.078	0.034	0.023	0.042	0.083	0.131	0.069	0.039	0.021	0.053	0.080
2004	202,735	0.132	0.090	0.041	0.027	0.054	0.110	0.129	0.063	0.038	0.020	0.051	0.070
2005	194,274	0.132	0.096	0.041	0.028	0.055	0.110	0.131	0.064	0.039	0.021	0.058	0.092
2006	217,062	0.138	0.094	0.043	0.028	0.057	0.101	0.126	0.061	0.039	0.020	0.057	0.097
2007	255,042	0.138	0.089	0.044	0.026	0.062	0.111	0.119	0.061	0.036	0.021	0.054	0.086

Table 2-4 Summary Statistics for Subsidized and non-Subsidized Spillover Variables (calculated based on value added tax)

		Subsidized						Non-Subsidized					
		Horizontal		Backward		Forward		Horizontal		Backward		Forward	
Year	Number of Obs	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1998	96,135	0.053	0.062	0.014	0.011	0.009	0.018	0.151	0.078	0.045	0.024	0.059	0.085
1999	104,253	0.049	0.056	0.013	0.012	0.007	0.012	0.169	0.089	0.052	0.027	0.069	0.107
2000	102,745	0.049	0.053	0.013	0.011	0.009	0.019	0.182	0.094	0.058	0.030	0.076	0.118
2001	114,735	0.049	0.050	0.013	0.011	0.008	0.017	0.187	0.095	0.057	0.029	0.080	0.123
2002	122,464	0.063	0.064	0.017	0.014	0.008	0.016	0.178	0.088	0.055	0.028	0.081	0.127
2003	138,377	0.070	0.075	0.018	0.018	0.013	0.038	0.177	0.083	0.056	0.027	0.085	0.130
2004	202,735												
2005	194,274	0.061	0.058	0.017	0.015	0.014	0.035	0.207	0.102	0.064	0.034	0.101	0.162
2006	217,062	0.054	0.054	0.015	0.014	0.015	0.045	0.214	0.103	0.069	0.034	0.102	0.153
2007	255,042	0.047	0.056	0.013	0.015	0.012	0.038	0.214	0.097	0.068	0.032	0.105	0.159

Notes: Since the information on value added is missing for 2004, we leave the summary statistics for 2004 with blank.

Table 3 OLS and Olley-Pakes Regression with Contemporaneous Spillover Variables with Tariff controls: with vs. without firm-fixed effects (sample: all firms)

	Dependent variable: logY		Dependent variable: lnTFP	
LogL	0.0914***	0.0755***		
	(0.0036)	(0.0041)		
LogK	0.0278***	0.0347***		
	(0.0016)	(0.0024)		
LogM	0.766***	0.865***		
	(0.0069)	(0.0042)		
Foreignshare (by HK-Taiwan-Macau)	-0.0018	-0.0018	-0.00353	0.0231***
	(0.0031)	(0.0052)	(0.0031)	(0.0049)
Foreignshare (by other countries)	0.0076**	0.0644***	0.0054*	0.115***
	(0.0032)	(0.0057)	(0.0032)	(0.0089)
Stateshare	-0.0168***	-0.0586***	-0.0201***	-0.126***
	(0.0036)	(0.0060)	(0.0032)	(0.0108)
Horizontal	0.162*	0.128	0.164*	0.0771
	(0.088)	(0.116)	(0.0871)	(0.110)
Backward	0.813***	0.956***	0.807***	1.096***
	(0.259)	(0.331)	(0.256)	(0.328)
Forward	0.163*	0.185	0.160*	0.190
	(0.0869)	(0.114)	(0.0865)	(0.119)
lnTariff	-0.0385**	0.00198	-0.0381**	-0.0129
	(0.0150)	(0.0319)	(0.0151)	(0.0319)
lnTariff_backward	-0.0276	-0.0061	-0.0289	-0.0236
	(0.0188)	(0.0312)	(0.0189)	(0.0319)
lnTariff_forward	-0.0064	-0.0396**	-0.0066	-0.0410**
	(0.0080)	(0.0173)	(0.0079)	(0.0178)
Constant	1.921***	0.956***	1.721***	1.749***
	(0.0704)	(0.123)	(0.0577)	(0.118)
Firm-fixed effect	Yes	No	Yes	No
Observations	1,545,626	1,545,626	1,545,626	1,545,626
R-squared	0.831	0.949	0.179	0.237

Notes: Robust clustered standard errors are presented in parentheses. In estimates using logY (i.e., in column (1) and (2) as the dependent variable, logL, logM, and logK are included as regressors along with the firm-level controls, sector-level FDI and tariff variables. When the dependent variable is lnTFP (i.e. as in column (3) and (4)), the estimation procedure is two-stage. In the first stage, we use the OP regression method to obtain estimates for the input coefficients and then calculate lnTFP (the residual from the production function). In the second stage, we regress lnTFP on the remaining controls (firm-level foreign share, state share, sector-level FDI variables, and tariff variables).

*Significant at 10-percent level

**Significant at 5-percent level

***Significant at 1-percent level

Table 4 Olley and Pakes Regressions with Contemporaneous Spillover Variables and Tariff Controls: all firms, foreign-invested, domestic firms with zero foreign investment

	All firms	Foreign-invested firms	Domestic firms (0 foreign share)
Foreignshare (by HK-Taiwan-Macau)	-0.0035	0.003	
	(0.0031)	(0.0048)	
Foreignshare (by other countries)	0.0054*	0.0132***	
	(0.0032)	(0.0049)	
Stateshare	-0.0201***	0.0023	-0.0193***
	(0.0032)	(0.0075)	(0.0034)
Horizontal	0.164*	0.115	0.191**
	(0.0871)	(0.0991)	(0.0883)
Backward	0.807***	0.860***	0.801***
	(0.256)	(0.276)	(0.268)
Forward	0.160*	0.246***	0.0920
	(0.0865)	(0.0876)	(0.0920)
lnTariff	-0.0381**	-0.0241	-0.0417**
	(0.0151)	(0.0182)	(0.0164)
lnbwTariff	-0.0289	-0.0167	-0.0350
	(0.0189)	(0.0176)	(0.0211)
lnfwTariff	-0.0066	-0.0203*	-0.0027
	(0.0079)	(0.0116)	(0.0072)
Constant	1.721***	2.002***	2.053***
	(0.0577)	(0.0598)	(0.0416)
Observations	1,545,626	348,029	1,197,597
R-squared	0.179	0.204	0.166
Horizontal*dummy		-0.124***	
		(0.046)	
F-stat (Horizontal*dummy=0)		7.14	
Prob > *F*		0.010	
Backward*dummy		0.011	
		(0.009)	
F-stat (Backward*dummy=0)		0.62	
Prob > *F*		0.433	
Forward*dummy		-0.011*	
		(0.006)	
F-stat (Forward*dummy=0)		19.81	
Prob > *F*		0	
F-stat (interaction term jointly zero)		7.76	
Prob > *F*		0.0002	

Notes: Robust clustered standard errors are presented in parentheses. The dependent variable lnTFP. Each regression includes firm-fixed effects and year dummies. The bottom of the table reports the results of tests, which compares whether three sector-level FDI variables are different across the two sub-samples of foreign-invested firms and domestic firms. The dummy is defined as 1 if firm i has non-zero foreign share at period t, 0 otherwise.

Table 5 Olley and Pakes Regressions with Contemporaneous Spillover Variables and Tariff controls: all firms, foreign-invested, and domestic firms with zero foreign investment (sector-level FDI are calculated based on sources of FDI)

	All firms	Foreign-invested firms	Domestic firms (0 foreign investment)
Foreign share (HK-Taiwan-Macau)	-0.0028	0.00312	
	(0.003)	(0.0047)	
Foreign share (by other countries)	0.0059*	0.013***	
	(0.0032)	(0.0048)	
Horizontal_HK	-0.0198	0.0143	-0.0647
	(0.099)	(0.106)	(0.105)
Backward_HK	0.570	0.339	0.697
	(0.580)	(0.581)	(0.659)
Forward_HK	-0.227	-0.241	-0.162
	(0.177)	(0.154)	(0.217)
Horizontal_FR	0.284**	0.183	0.350***
	(0.132)	(0.149)	(0.131)
Backward_FR	0.872*	1.110**	0.764*
	(0.445)	(0.522)	(0.437)
Forward_FR	0.332**	0.457***	0.214
	(0.148)	(0.116)	(0.179)
lnTariff	-0.0263*	-0.00987	-0.0313*
	(0.0154)	(0.0180)	(0.0165)
lnTariff_backward	-0.0379	-0.0265	-0.0413*
	(0.0231)	(0.0259)	(0.0245)
lnTariff_forward	-0.0037	-0.0153	-0.0008
	(0.0078)	(0.0118)	(0.0071)
Constant	1.715***	1.997***	2.046***
	(0.0638)	(0.0703)	(0.0440)
Observations	1,545,626	348,029	1,197,597
R-squared	0.180	0.205	0.167
F-stat (HHK=HFR)	3.01	0.80	5.42
Prob>*F*	0.088	0.374	0.023
F-stat (BHK=BFR)	0.11	0.61	0
Prob>*F*	0.736	0.438	0.944
F-stat (FHK=FFR)	3.61	10.63	1.02
Prob>*F*	0.062	0.002	0.32
F-stat (three conditions jointly)	4.64	6.99	4.16
Prob>*F*	0.006	0.004	0.009

Notes: Robust clustered standard errors are presented in parentheses. The dependent variable for each regression is lnTFP. Each regression includes firm-fixed effects and year dummies. HHK = Horizontal (by HK-Taiwan-Macau investors), HFR = Horizontal (by other countries). BHK = Backward (by HK-Taiwan-Macau investors), BFR = Backward (by other countries). FHK = Forward (by HK-Taiwan-Macau investors), FFR = Forward (by other countries).

Table 6 Olley and Pakes Regressions with Contemporaneous Spillover Variables and Tariff controls: non-SOEs vs. SOEs (with the sample of all firms, foreign-invested, and domestic firms with zero foreign share)

	All firms		Foreign-invested firms		Domestic firms (zero foreign share)	
	Non-SOEs	SOEs	Non-SOEs	SOEs	Non-SOEs	SOEs
Foreign share (by HK-Taiwan-Macau)	-0.0037	0.0348	0.0033	-0.0734		
	(0.003)	(0.0545)	(0.0048)	(0.0663)		
Foreign share (by other countries)	0.0052	0.098**	0.013***	0.082		
	(0.0031)	(0.0393)	(0.0049)	(0.0692)		
State share	-0.0016	-0.0256***	0.0037	0.0172	-0.0017	-0.0259***
	(0.0030)	(0.0041)	(0.0078)	(0.0305)	(0.0033)	(0.0041)
Horizontal	0.164*	0.109	0.117	-0.506	0.194**	0.111
	(0.088)	(0.100)	(0.099)	(0.444)	(0.089)	(0.100)
Backward	0.785***	1.027***	0.850***	2.893***	0.765***	1.005***
	(0.253)	(0.349)	(0.275)	(0.844)	(0.262)	(0.350)
Forward	0.162*	0.166	0.245***	0.483**	0.0867	0.169
	(0.0851)	(0.128)	(0.0875)	(0.219)	(0.0882)	(0.132)
lnTariff	-0.0349**	-0.0526**	-0.0237	-0.0676**	-0.0375**	-0.0519**
	(0.0154)	(0.0198)	(0.0183)	(0.0312)	(0.0171)	(0.0198)
lnTariff_backward	-0.0285	-0.0163	-0.0169	0.00579	-0.0354*	-0.0159
	(0.0185)	(0.0337)	(0.0176)	(0.0705)	(0.0207)	(0.0338)
lnTariff_forward	-0.0086	0.0065	-0.0205*	0.0705***	-0.0046	0.006
	(0.0082)	(0.0077)	(0.0115)	(0.0245)	(0.0074)	(0.0077)
Constant	1.721***	2.545***	1.913***	1.413***	1.663***	2.550***
	(0.0576)	(0.0690)	(0.0723)	(0.118)	(0.0598)	(0.0701)
Observations	1,418,632	126,994	345,631	2,398	1,073,001	124,596
R-squared	0.186	0.078	0.204	0.222	0.173	0.077
Horizontal*ownership	-0.184**		-0.030		-0.201**	
	(0.091)		(0.193)		(0.095)	
F-stat (Horizontal * ownership = 0)	4.06		0.02		4.4	

Prob>*F*	0.048	0.879	0.04
Backward*ownership	-0.018	-0.236	-0.042
	(0.220)	(0.350)	(0.233)
F-stat (Backward * ownership = 0)	0.01	0.46	0.03
Prob>*F*	0.934	0.502	0.857
Forward*ownership	0.007	-0.100	0.043
	(0.064)	(0.109)	(0.065)
F-stat (Forward * ownership = 0)	0.01	0.85	0.44
Prob>*F*	0.915	0.36	0.51
F-stat (interaction terms jointly zero)	6.55	1.46	6.68
Prob>*F*	0.001	0.235	0.001

Notes: Robust clustered standard errors are presented in parentheses. The dependent variable for all regression is lnTFP. All regressions include firm fixed effects and year dummies. Ownership is a dummy variable, which equals one if a firm is a SOE and zero otherwise.

Table 7 Olley and Pakes Regressions for Grouped Data with Contemporaneous Subsidized and non-Subsidized Spillover Variables (constructed based on income tax) and Tariff Controls: non-SOEs vs. SOEs (All firms, foreign-invested, and domestic firms with zero foreign investment

	All firms		Foreign-invested firms		Domestic firms (0 foreign investment)	
	non-SOEs	SOEs	non-SOEs	SOEs	non-SOEs	SOEs
Foreign share (by HK-Taiwan-Macau)	-0.00381	0.0363	0.00368	-0.0766		
	(0.00302)	(0.0543)	(0.00484)	(0.0675)		
Foreign share (by other countries)	0.00522	0.0986**	0.0137***	0.0807		
	(0.00313)	(0.0388)	(0.00498)	(0.0690)		
State share	-0.00174	-0.0254***	0.00420	0.0180	-0.00206	-0.0257***
	(0.00290)	(0.00420)	(0.00767)	(0.0307)	(0.00331)	(0.00421)
Hor_subsidized	0.117	0.103	0.0512	-0.595	0.163	0.103
	(0.107)	(0.133)	(0.109)	(0.511)	(0.111)	(0.134)
Bw_subsidized	2.189***	2.833***	2.065***	3.203***	2.286***	2.822***
	(0.644)	(0.611)	(0.475)	(0.986)	(0.799)	(0.628)
Fw_subsidized	0.165	0.203	0.238***	0.526**	0.0817	0.213
	(0.107)	(0.151)	(0.0859)	(0.259)	(0.141)	(0.158)
Hor_non_subsidized	0.189*	-0.0729	0.179*	-0.429	0.188	-0.0702
	(0.104)	(0.117)	(0.103)	(0.355)	(0.114)	(0.119)
Bw_non_subsidized	-0.934	-1.173**	-0.649	2.287*	-1.051	-1.175**
	(0.623)	(0.464)	(0.474)	(1.239)	(0.749)	(0.471)
Fw_non_subsidized	0.184**	0.222**	0.261***	0.403**	0.132	0.221**
	(0.0885)	(0.105)	(0.0683)	(0.163)	(0.122)	(0.110)
lnTariff	-0.0346**	-0.0458**	-0.0262*	-0.0712**	-0.0366**	-0.0451**
	(0.0144)	(0.0184)	(0.0155)	(0.0329)	(0.0163)	(0.0185)
lnTariff_backward	-0.0170	0.00734	-0.00343	0.0123	-0.0249	0.00716
	(0.0179)	(0.0305)	(0.0175)	(0.0727)	(0.0200)	(0.0306)
lnTariff_forward	-0.00981	0.00613	-0.0211*	0.0695***	-0.00610	0.00561
	(0.00782)	(0.00679)	(0.0110)	(0.0233)	(0.00716)	(0.00680)
Constant	1.728***	2.499***	1.920***	1.431***	1.673***	2.504***

	(0.0531)	(0.0632)	(0.0654)	(0.118)	(0.0577)	(0.0645)
Observations	1,418,632	126,994	345,631	2,398	1,073,001	124,596
R-squared	0.187	0.079	0.205	0.223	0.174	0.078
F-stat (HS=HNS)	0.28	0.96	0.98	0.42	0.03	0.88
Prob>F	0.596	0.332	0.327	0.518	0.862	0.351
F-stat (BS=BNS)	6.72	19.12	10.39	0.42	5.01	18.02
Prob>*F*	0.012	0.0001	0.002	0.52	0.029	0.0001
F-stat (FS=FNS)	0.02	0.02	0.14	0.74	0.06	0
Prob>*F*	0.882	0.889	0.705	0.394	0.813	0.955
F-stat (three conditions jointly)	2.61	7.46	3.92	0.32	1.99	6.85
Prob>*F*	0.06	0.0003	0.013	0.808	0.126	0.0005

Notes: Robust clustered standard errors are presented in parentheses. The dependent variable for all regressions is lnTFP. All regressions include firm fixed effect and year dummy variables. HS = subsidized horizontal, and HNS = non-subsidized horizontal; BS = subsidized backward, and BNS = non-subsidized backward; FS = subsidized forward, and FNS = non-subsidized forward.

Table 8 Olley and Pakes Regressions for Grouped Data with Contemporaneous Subsidized and non-Subsidized Spillover Variables (calculated based on value added tax) and Tariff Controls: non-SOEs vs. SOEs (all firms, foreign-invested, domestic firms)

	All firms		Foreign-invested firms		Domestic firms	
	non-SOEs	SOEs	non-SOEs	SOEs	non-SOEs	SOEs
Foreign share (by HK-Taiwan-Macau)	-0.0041	0.0371	0.003	-0.0765		
	(0.0031)	(0.0579)	(0.0044)	(0.0716)		
Foreign share (by other countries)	0.0050*	0.121***	0.0130***	0.0829		
	(0.0026)	(0.0357)	(0.0048)	(0.0698)		
State share	-0.001	-0.0250***	-0.0016	0.0312	0.0007	-0.0253***
	(0.0033)	(0.0045)	(0.0091)	(0.0318)	(0.0035)	(0.0046)
Hor_subsidized	0.0398	0.230*	0.0177	-0.683	0.0662	0.249*
	(0.0871)	(0.134)	(0.0865)	(0.416)	(0.0963)	(0.135)
Bw_subsidized	0.831	1.133**	1.138*	2.560***	0.636	1.086**
	(0.534)	(0.523)	(0.572)	(0.793)	(0.574)	(0.535)
Fw_subsidized	1.068***	0.685***	1.161***	0.785***	0.943***	0.659***
	(0.130)	(0.114)	(0.140)	(0.183)	(0.147)	(0.118)
Hor_non_subsidized	0.240**	0.116	0.214**	-0.518	0.255**	0.117
	(0.0928)	(0.111)	(0.0966)	(0.497)	(0.0978)	(0.112)
Bw_non_subsidized	0.765**	0.695	0.666**	2.763**	0.842*	0.663
	(0.376)	(0.527)	(0.314)	(1.109)	(0.456)	(0.537)
Fw_non_subsidized	-0.0597	0.00991	-0.00319	0.408	-0.105	0.0161
	(0.102)	(0.136)	(0.111)	(0.258)	(0.0990)	(0.144)
lnTariff	-0.0394**	-0.0515**	-0.0295*	-0.0408	-0.0424**	-0.0510**
	(0.0165)	(0.0209)	(0.0175)	(0.0355)	(0.0187)	(0.0209)
lnTariff_backward	-0.0324	-0.0135	-0.0263	0.0151	-0.0361	-0.0122
	(0.0198)	(0.0369)	(0.0185)	(0.0737)	(0.0223)	(0.0371)
lnTariff_forward	-0.00487	0.0129*	-0.0134	0.0568**	-0.0017	0.0123
	(0.0079)	(0.0076)	(0.0110)	(0.0242)	(0.0072)	(0.0076)

Constant	2.074***	2.472***	1.939***	1.390***	1.672***	2.553***
	(0.0401)	(0.0650)	(0.0723)	(0.127)	(0.0666)	(0.0721)
Observations	1,225,481	117,594	299,177	2,323	926,304	115,271
R-squared	0.205	0.084	0.233	0.213	0.185	0.083
F-stat (HS=HNS)	6.36	0.64	8.51	0.34	4.14	0.8
Prob>F	0.014	0.428	0.005	0.563	0.046	0.374
F-stat (BS=BNS)	0.01	0.26	0.42	0.04	0.05	0.23
Prob>*F*	0.932	0.61	0.521	0.848	0.823	0.632
F-stat (FS=FNS)	29.45	14.94	24.17	1.9	26.52	11.24
Prob>*F*	0	0.0003	0	0.173	0	0.001
F-stat (three conditions jointly)	13.49	8.08	11.09	1.14	10.22	6.34
Prob>*F*	0	0.0001	0	0.341	0	0.001

Notes: Robust clustered standard errors are presented in parentheses. The dependent variable for all regressions is lnTFP. All regressions include firm fixed effect and year dummy variables. Since the information on value added is missing for the year of 2004, we exclude the year of 2004 from regressions. HS = subsidized horizontal, and HNS = non-subsidized horizontal; BS = subsidized backward, and BNS = non-subsidized backward; FS = subsidized forward, and FNS = non-subsidized forward.

APPENDIX TABLES

Table A-1 Average Wages Comparison

Year	Mean of average wages from the data	Average wages from the National Statistical Yearbook (for the manufacturing industry)	Average wages from the National Statistical Yearbook (for SOEs manufacturing firms)
1998	9,795	7,064	6,981
1999	8,072	7,794	7,611
2000	9,038	8,750	8,554
2001	10,329	9,774	9,590
2002	10,586	11,001	10,876
2003	11,002	12,496	12,601
2004	13,588		
2005	14,087	15,757	16,963
2006	16,925	17,966	20,317
2007	19,957	20,884	23,913

Notes: Wages are measured in yuan/year for one person. To obtain means of average wages of the sample, we first calculate the average wage for each firm in each year by dividing total wages by the number of total employees then take the means of these averages. The official information on average wage is missing for the year of 2004, therefore we leave them with blank.

Table A-2 Summary of Estimated Elasticities of Input Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Coefficients on Input Variables Estimated by OLS with firm Fes and time dummies									
	Full	FIE	Domestic	Full_nonSOEs	Full_SOEs	FIE_nonSOEs	FIE_SOEs	Domestic_nonSOEs	Domestic_SOEs
logL	0.0918***	0.122***	0.0818***	0.0920***	0.0828***	0.122***	0.0798***	0.0809***	0.0820***
	(0.00413)	(0.00765)	(0.00336)	(0.00434)	(0.00575)	(0.00772)	(0.0207)	(0.00360)	(0.00593)
logK	0.0278***	0.0374***	0.0249***	0.0285***	0.0193***	0.0374***	0.0303*	0.0255***	0.0182***
	(0.00159)	(0.00266)	(0.00152)	(0.00157)	(0.00311)	(0.00267)	(0.0152)	(0.00156)	(0.00306)
logM	0.766***	0.732***	0.776***	0.768***	0.742***	0.732***	0.844***	0.781***	0.740***
	(0.00683)	(0.00709)	(0.00735)	(0.00732)	(0.0107)	(0.00713)	(0.0359)	(0.00811)	(0.0110)
Obs	1,545,626	348,029	1,197,597	1,418,632	126,994	345,694	2,403	1,073,001	124,596
Coefficients on Input Variables Estimated by Olley and Pakes Regression									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Full	FIE	Domestic	Full_nonSOEs	Full_SOEs	FIE_nonSOEs	FIE_SOEs	Domestic_nonSOEs	Domestic_SOEs
logL	0.0888***	0.153***	0.068***	0.0951***	0.012**	0.154***	0.0231	0.0743***	0.012**
	(0.0019)	(0.0035)	(0.0019)	(0.0022)	(0.005	(0.004)	(0.0245)	(0.0022)	(0.005)
logK	0.0436***	0.0427***	0.044***	0.0464***	0.0205***	0.0428***	0.0644*	0.0473***	0.0202***
	(0.0018)	(0.003)	(0.0016)	(0.0015)	(0.004)	(0.0024)	(0.027)	(0.0018)	(0.004)
logM	0.771***	0.725***	0.785***	0.770***	0.772***	0.725***	0.836***	0.786***	0.771***
	(0.004)	(0.006)	(0.005)	(0.0048)	(0.010)	(0.007)	(0.046)	(0.005)	(0.009)
Obs	779,148	192,146	587,002	724,371	54,777	191,006	1,140	533,365	53,637

Table A-3 FDI Effect on Price Level

	Dependent variable: log of price index	
Horizontal	0.008	-0.008
	(0.017)	(0.014)
Backward	-0.097**	-0.097**
	(0.046)	(0.045)
Forward	-0.024	-0.024
	(0.016)	(0.015)
Robust Standard Error	No	Yes
Year Dummies	Yes	Yes
Industry fixed effect	Yes	Yes
Number of observations	610	610
R-squared	0.58	0.58

Table A-4 Summary Statistics on Tariff (by sectors)

Industry names	Tariff Mean	Tariff Diff b/w 1998 and 2007	Tariff_backward Mean	Tariff_forward Mean
1.Grain mill products	41.002	-18.29 (means fall by 18 percentage)	11.410	19.799
2.Forage	13.501	-7.87	19.654	1.932
3.Vegetable oid refining	19.85	-21.77	2.752	8.796
4.Sugar manufacturing	37.101	10.710	5.837	14.656
5.Slaughtering and meat processing	18.949	-4.510	10.705	15.193
6.Fish and fish productions	16.052	-12.419	12.196	10.698
7.All other food manufacuturing	22.206	-13.238	17.262	12.642
8.Wines, spirits and liquors	27.569	-34.290	16.811	4.384
9.Soft drink and other beverage	28.916	-20.560	16.372	1.328
10.Tobacco products	49.584	-24.000	4.275	
11.Cotton textiles	14.96	-13.88	4.168	14.558
12.Woolen textiles	14.96	-13.88	7.638	11.505
13.Hemp textiles	14.96	-13.88	5.044	8.632
14.Textiles productions	17.674	-15.005	12.643	12.958
15.Knitted and crocheted fabrics and articles	20.082	-17.936	12.841	13.452
16.Wearing apparel	21.997	-16.212	14.651	11.568
17.Leather, fur, down and related products	19.176	-8.271	7.629	3.691
18.Products of wood, bamboo, cane, palm, straw	8.849	-8.346	4.591	8.130
19.Furniture	11.7	-18.51	10.835	12.740
20.Paper and paper products	11.975	-12.734	4.862	13.265
21.Printing, reproduction of recording media	13.584	-14.950	10.897	15.092
22.Stationary and related products	18.112	-5.306	11.426	9.624

23.Toys, sporting and athletic and recreation products	12.120	-14.198	11.291	1.494
24.Petroleum and nuclear processing	6.499	-0.930	6.647	11.159
25.Coking	5.479	-0.080	9.099	7.447
26.Basic chemicals	6.848	-3.13	5.342	10.513
27.Chemical fertilizers	7.511	3.15	8.390	2.418
28.Chemical pesticides	8.974	-2.07	7.906	1.169
29.Paits, varnishes and similar coatings, printing ink and mastics	9.242	-3.71	6.644	10.096
30.Man-made chemical products	10.043	-6.108	6.844	11.981
31.Special chemical products	12.661	-5.804	6.906	10.784
32.Chemical products for daily use	16.088	-11.882	9.763	7.675
33.Medical and pharmaceutical products	6.535	-4.599	6.911	1.817
34.Chemical fibers	9.825	-12.423	6.639	11.829
35.Rubber products	16.167	-3.752	8.967	12.782
36.Plastic products	12.583	-8.299	7.137	12.860
37.Cement, lime and plaster	11.811	-2.741	10.929	9.913
38.Glass and glass products	15.457	-4.890	7.790	10.669
39.Pottery, china and earthenware	18.236	-12.03	9.899	6.928
40.Fireproof materials	9.777	-3.671	9.550	7.751
41.Other nonmetallic minetal products	10.030	-2.355	7.801	8.187
42.Iron-smelting	6.601	-3.76	6.809	7.720
43.Steel-smelting	6.601	-3.76	7.538	9.424
44.Steel pressing	6.601	-3.76	6.700	11.368
45.Alloy iron smelting	6.601	-3.76	6.318	6.282
46.Nonferrous metal smelting	6.189	-2.382	5.554	7.897
47.Nonferrous metal pressing	5.63	-2.33	6.356	11.921
48.Metal products	12.788	-4.814	6.043	12.599
49.Boiler, engines and turbine	10.081	-4.635	7.551	10.693
50.Metalworking machinery	10.978	-5.201	8.875	8.637
51.Other general industrial machiney	10.869	-6.203	7.562	11.131

52.Agriculture, forestry, animal husbandry and fishing machinery	8.253	-5.070	9.018	1.163
53.Other special industrial equipment	9.871	-5.426	8.575	9.798
54.Railroad transport equipment	4.082	-1.34	8.528	2.403
55.Motor vehicles	29.126	-26.921	11.348	7.771
56.Parts and accessories for motor vehicles and their engines	17.584	-18.57	6.907	13.769
57.Ship building	7.365	-1.151	9.258	2.488
58.Other transport equipment	25.944	-9.094	8.338	3.349
59.Generators	10.725	-6.465	9.211	9.195
60.Household electric appliances	18.441	-7.963	9.438	7.640
61.Other electric machinery and equipment	15.103	-5.202	8.425	12.144
62.Telecommunication equipment	10.992	-13.480	6.546	4.279
63.Electronic computer	8.422	-14.87	6.629	5.235
64.Other computer peripheral equipment	8.352	-14.828	6.780	7.261
65.Electronic element and device	4.912	-7.01	7.641	10.988
66.Radio, television and communication equipment and apparatus	21.374	-13.97	8.162	5.635
67.Other electronic and communication equipment	9.528	-5.450	8.450	5.169
68.Instruments, meters and other measuring equipment	10.097	-5.150	8.621	8.603
69.Cultural and office equipment	10.460	-9.548	8.647	4.231
70.Arts and crafts products	16.980	-7.374	10.600	6.483
71.Other manufacturing products	19.324	-5.036	10.777	9.855
On average (all sectors)	12.691	-8.862	8.191	9.185